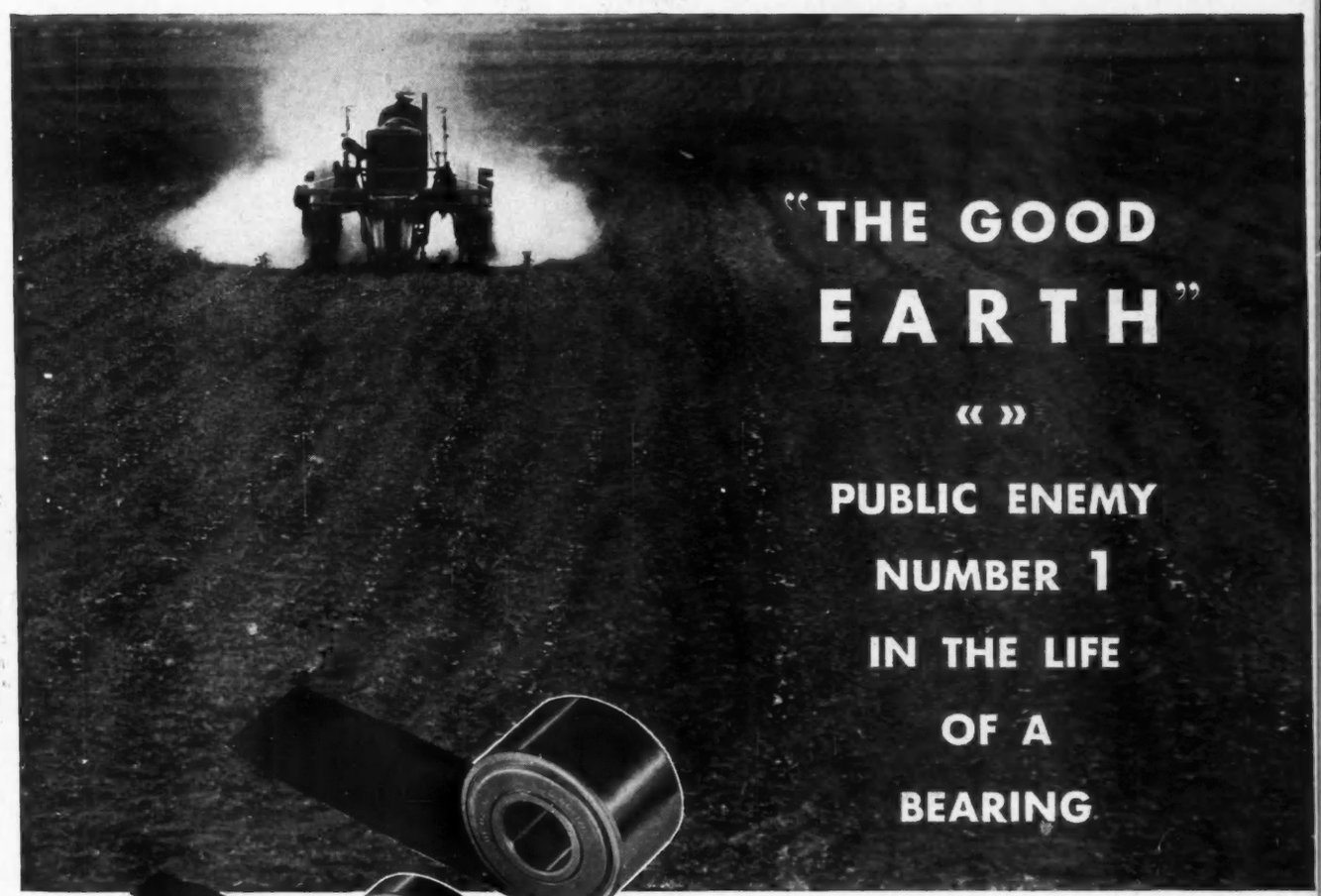
JUN 19 1937

AUTOMOTIVE INDUSTRIES

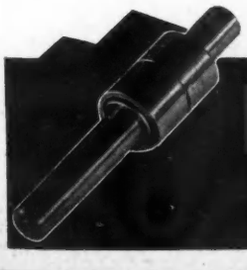
LAND — AIR — WATER

JUNE 19, 1937



. . . But N-D-Seals defeat dirt

Abrasive dirt is kept *out* where it can do no harm—and lubricant is kept *in* where it belongs, with New Departure self-sealed and Lubricated-for-Life ball bearings. New Departure pioneered the seal bearing. Eight million are in successful use today. New Departure, Division General Motors Corporation, Bristol, Connecticut.



NEW DEPARTURE

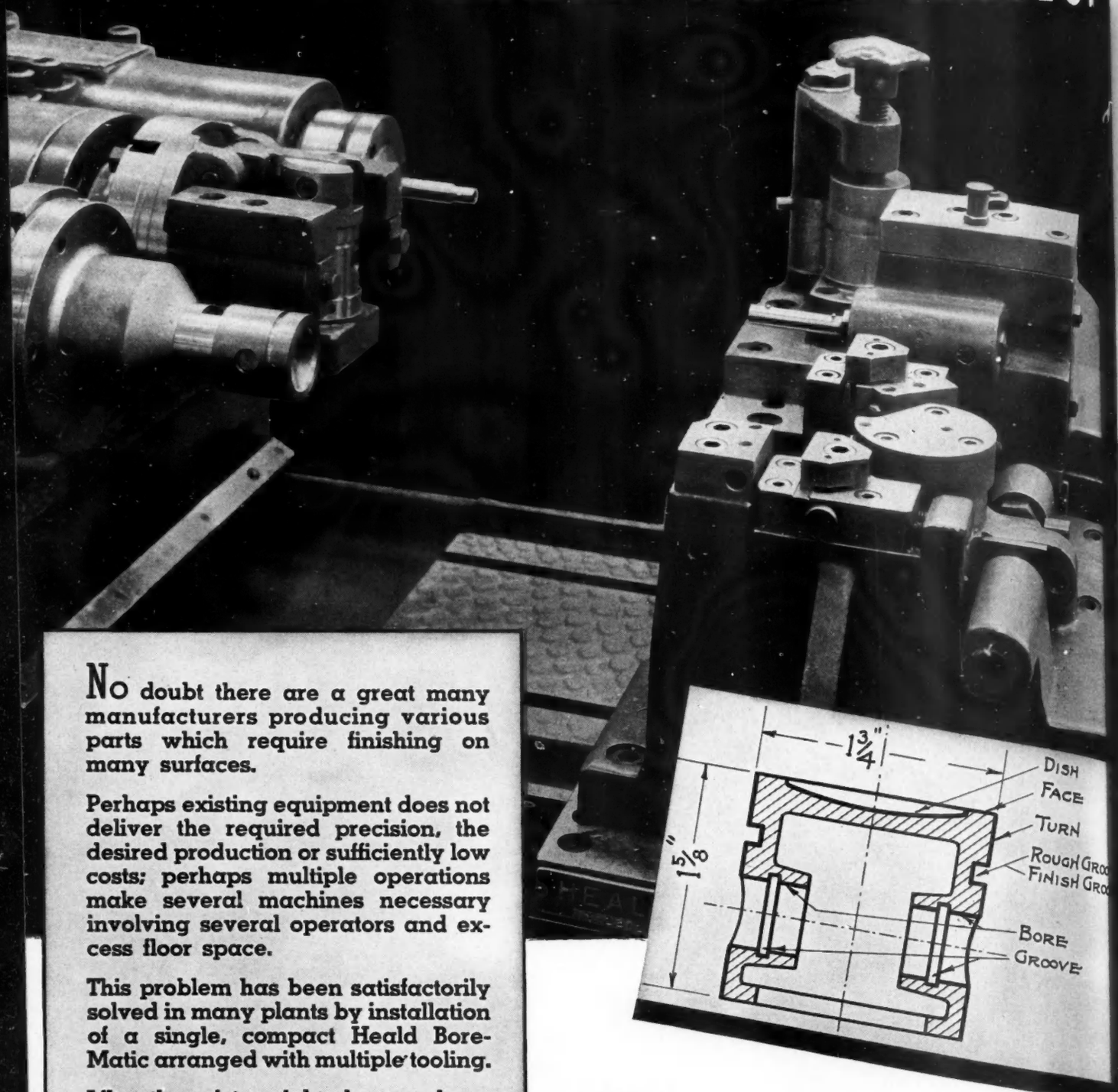
N-D-SEAL BEARINGS

2557

MULTIPLY PROFITS

with Multiple Precision Operations

on HEALD BORE-MATICS



No doubt there are a great many manufacturers producing various parts which require finishing on many surfaces.

Perhaps existing equipment does not deliver the required precision, the desired production or sufficiently low costs; perhaps multiple operations make several machines necessary involving several operators and excess floor space.

This problem has been satisfactorily solved in many plants by installation of a single, compact Heald Bore-Matic arranged with multiple tooling.

Like the piston job shown above which has seven surfaces precision finished in one cycle on one Heald No. 48A Bore-Matic.

Results . . . greater accuracy . . . higher production . . . lower costs . . . in short, multiplied profits.

THE

Heald Machine Co

Worcester, Mass., U. S. A.

AUTOMOTIVE INDUSTRIES
With AUTOMOBILE

Reg. U. S. Pat. Off.
Published Weekly

Volume 76 Number 25

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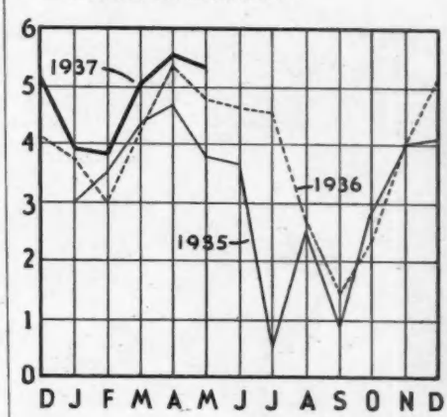
AUTOMOTIVE PRODUCTION*

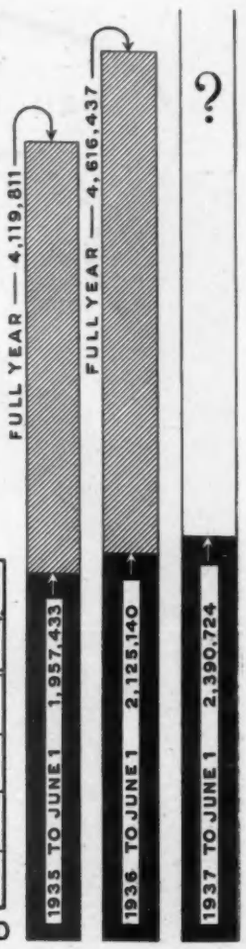
Passenger Cars and Trucks —U. S. and Canada

Bar charts at the right represent total production to June 1st of year indicated.

Numbers at left of monthly graph below show production in 100,000's.

*From Department of Commerce Report and Automobile Manufacturers' Ass'n.





An Idea in Zinc

With current automobile styling has come a general cleaning up of exteriors—faired headlamps and tail lights, inwardly curving hardware and fittings. As a part of this picture we note the disappearance of the familiar twin horns so popular in the development of frontal styling only a few years ago. Horns are less obtrusive but must still be vocal, a change which presented new problems. As the horns moved under cover they entered cramped quarters. And with this came the entry of the die cast horn body, utilizing the flexibility of the die casting process to develop complex curved surfaces, which can do an excellent job in a small compass. Here was a perfect setting for the Zamak type alloys based on zinc of 99.99+ per cent purity. Perfect castings of high structural strength and stability are combined with tonal qualities which are said to surpass the tone of conventional instruments. This is but one outstanding example of the possibilities inherent in the high grade zinc alloy die casting. The New Jersey Zinc Company, 160 Front Street, New York, N. Y.

Idea No. 1

FORD PRODUCTION ORDER:

1500 lunches, piping hot; growing boy's size

LITTLE ROUGE SCHOOLHOUSE

HUMMING with talk, full of life and vigor, 1500 boys from the Henry Ford Trade School go daily to their own big dining-room at the Rouge Plant in Dearborn. Waiting is a hot lunch of the sort growing bodies and minds need.

These boys symbolize tomorrow's workman. Healthy, self-confident, filled with a sense of direction and opportunity in a complex civilization. They divide their time among classes, shop and play.

The Henry Ford Trade School was founded more than twenty years ago. Trade School shops are a separate unit in the big Ford plant. Trade School classrooms adjoin the shops. Both are complete and modern. The boys build no parts for Ford cars, but they do useful work from the time they enroll. Each earns a weekly cash scholarship that increases with his skill and experience. In addition, each gets $2 every week for a savings account that will form a nest egg on graduation.

To these boys the School means the opportunity to learn a trade, a chance to continue schooling through financial difficulties, and to lead a normal boyhood, earning while they learn.

In the mind of each the high principles of Ford workmanship are instilled. From the very outset these boys learn accuracy and precision. Talk about "five ten-thousandths of an inch" is mixed with their guess on the pitcher for today's game.

The boys are under no obligation to work in Ford plants after they are graduated — but most of them do. Nothing less than Ford standards thereafter will satisfy them. Ford traditions are safe in their hands. Those who pass from classroom to Rouge Plant cling to a quality ideal that helps to make the Ford V-8 the quality car in the low-price field.

Ford

FORD MOTOR COMPANY

Published Weekly
Founded 1895

AUTOMOTIVE INDUSTRIES

June 19, 1937
Vol. 76, No. 25

Market's Vitality "Amazing"

The retail market for automobiles continues to show amazing vitality in spite of widespread labor disturbances, a sagging stock market and an unsettled political situation, factors which ordinarily act as a brake on sales. Not even the normal seasonal decline is reflected in the latest delivery figures reported to the factories by dealers. Sales officials are finding no little encouragement in the fact that the automobile business keeps rolling along apparently indifferent to what used to prove effective deterrents to sales activity. It indicates to them that the public's appetite for motor cars is still far from being satisfied.

Retail Car Sales Volume Large

Gains Over Early May Periods Reported by Several Companies; Longer Selling Season Held Strike Result

Retail automobile sales have continued this week at a high level, notwithstanding the plant strikes which have prevented the building up of any large field stocks to provide choices. New orders are still coming in in good volume.

Instead of showing a seasonal drop from May to June, the aggregate deliveries of eight companies reporting by ten-day periods were up 2363 units for the first ten days of June, over the corresponding period of May. Gains were recorded by six of the eight companies. Another leading producer, compiling sales on a weekly basis, showed an increase of 9.5 per cent for the week ended June 12 over the preceding week and 8 per cent over the corresponding week in May.

Normally the trend from May to June is downward, with the average decline approximately 11 per cent. During the past 10 years, June registrations have averaged 297,667 vehicles compared with an average of 329,671 units for May. In only two of the 10 years has June exceeded May. That was in the depression years of 1932 and 1933. During five of the last 10 years, peak registrations have come in April.

The usual seasonal pattern, however, has been altered by the change from winter to fall introductions of new models. This year, the trend has been further upset by the labor situation which has prevented the industry from building up stocks to meet the spring demand. Unquestionably April and May sales would have risen to much higher levels had cars been available for delivery. That is one of the reasons why the selling season has been prolonged. But it is not the only reason. Factories report that their dealers are still booking a good volume of new business in addition to filling orders on hand. One of the major companies, which has not suffered from a car shortage this spring, enjoyed a slightly heavier volume of sales during the first 10 days of June than during like period of May. If the rate of sales shown so far in June holds up, domestic deliveries should be on a level with the estimated May volume

(*Turn to page 898, please*)

Seek Way to End "Wild Cat" Strikes

Union Promises Its Aid; Steel Mediation Board Appointed; Several Automobile Plant Stoppages End, Others Averted

Strenuous efforts have been promised by officials of the United Automobile Workers to end the series of unauthorized strikes, at least, so far as General Motors is concerned.

Homer Martin, president of the union, was in session with his general executive board on Thursday, June 17, in an attempt to work out a program of control. Earlier in the week the UAW-General Motors permanent wage scale and conference committee recommended to the International office that it advise locals to discipline instigators of such strikes by suspension or expulsion. Wyndham Mortimer and Ed Hall, first and second vice-presidents of the union, conferring with General Motors on the terms of a new agreement, pledged their aid toward ending the "wild cat" strikes.

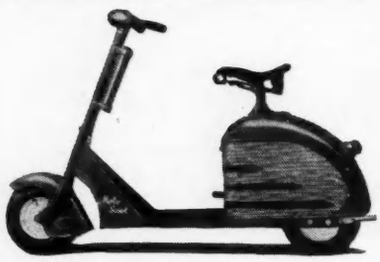
On Thursday afternoon the Federal Government took its first official notice of the steel strikers, which have begun to have an effect on some automotive operations, and appointed the Federal Steel Mediation Board. The board consists of Charles P. Taft of Cincinnati, Lloyd K. Garrison, dean of the law school at the University of Wisconsin and first chairman of the old National Labor Board, and Edward F. McGrady

(*Turn to page 899, please*)

This Week

NEWS includes the results of a special city-by-city survey on the used car market . . . An analysis showing that there is no "danger" in the amount of car financing today . . . Labor and production reports . . . Announcement of an attack by the Federal Trade Commission on General Motors' parts sales policy.

FEATURES include two materials articles, one on heavy metals for castings, and the other on new developments in the use of various materials . . . Financial analysis of the 1936 operations of the parts and accessories companies.



SCOOTERS like this are in production for individual use and for low cost deliveries from stores. Manufacturers of the "Moto-Scoot" claim 120 miles to the gallon of gasoline.

Motor Scooter Developed

A new motor scooter has made its appearance on the American market. It is known as the Moto-Scoot and is produced by Moto-Scoot Manufacturing Co. of Chicago. The machine is essentially a low-wheeled bicycle without crossbar to straddle. Control is by the handlebar-grip accelerator and a brake pedal. A fuel mileage of 120 to the gallon is claimed. The machine is recommended by the manufacturers for package delivery, for travel to and from work or school, for collections, delivering messages, or pleasure riding.

The engine is a single-cylinder fan-cooled design with aluminum piston and cylinder head. Its crankshaft is counter balanced and supported on ball bearings. The frame consists of a steel channel with plywood insert and is of such design as to give a very low center of gravity. A Tillotson carburetor is fitted, equipped with choke, throttle and

(Turn to page 897, please)

Parts Business Larger in 1936

Summary of Financial Statements Reflects Both Year End Activity and Enlarged Operations; Inventories Up

The very sharp increase in business done by the independent parts and equipment companies in 1936 is clearly shown in the fact that only three of 32 companies surveyed failed to show an expansion in the dollar value of inventories carried in year-end balance sheets. One of the 32 concerns included for past years has not yet reported for the year.

That a large number of the companies were obliged to increase manufacturing facilities to handle the larger volume of business was shown in the fact that 23 companies reported larger property accounts, net after depreciation reserves.

Within the sub-total of current assets, which were larger for 27 of the companies, 20 concerns reported smaller holdings of cash and securities, a more or less natural result of the expansion of inventories, and of receivables. Only one company showed smaller receivables than in 1935.

The change in the dates for presenting new automobile models, resulting in larger winter production of new cars, doubtless is another factor in accounting for the year-end inventory expansion. Parts and equipment companies in the past operated at a lower rate from November to February than they do now. After model introductions at the end of October, there is a period of large production for new cars which means substantial inventories of materials and work in process.

The Year's Results

	Increases	Declines
Inventories	28	3
Cash and securities	11	20
Receivables	30	1
Current assets	27	4
Current l'abilities	25	6
Net working capital	26	5
Plant and property (net)	23	8
Capital and surplus	28	3
Funded debt	1	7
Net income	26	5
Dividends	27	1

Another possible reason for the expansion of independent parts company business as a general thing may have been a degree of diversification of suppliers by the major automobile and truck manufacturers. It is likely that the background of labor troubles brought a little less integration, and consequently, a little more business for other than owned suppliers.

With the increase in current assets, there was apparent an increase in current liabilities. Only six companies were able to show current liability totals reduced from 1935. The increase in current liabilities is a natural concomitant of increased business volume. It means larger accounts payable for materials and larger accrued payrolls. It also means, at the present time, larger tax liabilities.

(Turn to page 914, please)

Pontiac Gain Widest in Volume Lines

April Passenger Car Registrations

	April 1937	March 1937	April 1936	Four Months 1937	Four Months 1936	Per Cent Change, 4 Months 1937 over 1936	Per Cent of Total Four Months 1937	Per Cent of Total Four Months 1936	Six Months 1937 Models	Six Months 1936 Models	Six Months Per Cent Change
Ford	98,502	85,811	86,298	313,284	250,037	+ 25.1	25.18	22.92	404,345	361,213	+ 11.7
Chevrolet	95,114	77,440	111,853	258,315	315,696	− 17.2	20.76	28.94	401,968	439,917	− 8.5
Plymouth	32,260	50,575	55,679	165,845	150,364	+ 10.1	13.33	13.78	255,248	213,216	+ 19.8
Dodge	19,624	28,727	28,395	91,177	75,920	+ 20.0	7.33	6.96	133,415	108,796	+ 22.8
Pontiac	24,776	19,830	20,122	69,527	51,906	+ 34.0	5.59	4.76	101,627	74,326	+ 36.8
Oldsmobile	23,537	18,476	24,682	63,997	63,230	+ 1.2	5.14	5.80	88,315	90,798	+ 2.6
Buick	23,230	16,780	18,956	61,335	47,876	+ 28.0	4.93	4.39	99,020	72,779	+ 36.1
Packard	12,615	10,309	6,690	36,068	16,883	+113.0	2.90	1.55	50,565	25,536	+ 98.5
Chrysler	7,742	9,225	6,652	29,431	18,109	+ 62.5	2.36	1.66	41,752	22,789	+ 83.2
Terraplane	6,522	8,498	9,888	28,220	24,600	+ 14.6	2.27	2.26	41,798	34,599	+ 20.8
Studebaker	8,796	7,656	7,775	26,077	20,620	+ 26.1	2.09	1.89	38,380	26,586	+ 44.2
Nash	9,315	7,250	5,043	25,355	13,134	+ 93.5	2.04	1.20	33,757	18,408	+ 83.0
De Soto	6,253	7,998	4,286	24,251	11,644	+108.0	1.95	1.07	33,416	15,403	+117.0
Willys	5,924	5,321	994	17,157	3,281	+424.0	1.38	.30	16,839	5,492	+244.0
La Salle	3,365	2,932	1,448	9,405	3,770	+149.0	.76	.34	13,877	5,962	+132.0
Lincoln	2,998	2,512	1,400	8,981	3,916	+129.5	.72	.36	12,745	4,888	+161.5
Hudson	1,414	1,633	2,809	5,782	7,717	− 25.0	.46	.71	9,148	11,885	− 23.0
Graham	1,643	1,307	1,654	4,818	4,634	+ 4.0	.39	.42	7,356	6,466	+ 13.7
Cadillac	1,410	1,015	1,310	4,140	3,830	+ 8.0	.33	.35	6,494	6,015	+ 7.8
Cord	114	127	148	426	237	+ 79.8	.03	.02	564	237	+138.0
Auburn	14	26	278	122	838	− 85.6	.00	.08	257	1,346	+ 91.0
Pierce-Arrow	21	29	100	120	276	− 56.5	.00	.03	220	428	− 48.6
Miscellaneous	90	96	726	590	2,333	− 75.0	.04	.21	2,195	4,283	− 48.8
Total	385,277	363,573	397,186	1,244,423	1,090,851	+ 14.1	100.00	100.00	1,795,301	1,548,368	+ 16.0
Chrysler Motors	65,879	96,525	95,012	310,704	256,037	+ 21.0	24.97	23.47	463,831	360,204	+ 28.6
Ford and Lincoln	101,498	88,323	87,698	322,265	253,953	+ 27.0	25.90	23.28	417,090	366,101	+ 13.8
General Motors	171,432	136,473	178,371	466,719	486,308	− 4.1	37.50	44.58	711,301	686,797	+ 3.7
All Others	46,468	42,252	36,105	144,735	94,553	+ 53.0	11.63	8.67	203,079	135,266	+ 50.0

Leaded Gasoline Gains

A steady rise in the percentage of leaded antiknock gasoline used by American motorists, with a corresponding drop in the consumption of unleaded regular and third-grade fuels, is reported in a nation-wide survey of gasoline sales by the Ethyl Gasoline Corporation. A parallel trend in compression ratios of automobile engines is noted, indicating that motor car owners are turning more and more to antiknock fuel as engine efficiencies increase.

Sales of Ethyl or premium gasoline with an antiknock rating of seventy-six octane or higher climbed from 558,900,000 gals. in 1934, to 622,700,000 gals. in 1935; and to 783,300,000 gals. in 1936. Engine compression ratio averages for the same years were 5.72, 5.99, 6.19, respectively.

Leaded regular gasoline, rated at seventy octane, increased in gallonage from 10,139,600,000 to 12,580,500,000, while total consumption of unleaded fuel of both the regular and the third-grade variety showed a percentage decline of 4 per cent in the same three-year period. Actual gallonage in all classifications increased, however, as total consumption for the country was registered at 16,683,100,000; 17,742,200,000; and 19,622,200,000 gallons for each of the three years.

"Danger" in Financing Scouted

Ratio of New Car Financing to Registrations Actually Dropped in First Quarter, Reports Ayres

by **MILAN V. AYRES**, secretary and analyst, National Association of Sales Finance Companies

(Special to AUTOMOTIVE INDUSTRIES)

I am told that certain financial writers are saying that the volume of automobile financing is again becoming "dangerous." I don't know just what they mean. That which is dangerous is frightful. Was financing formerly frightful, and is it again becoming so?

We must admit that the sales finance companies did a bigger business in automobile financing in 1936 than in the previous high year of 1929, and that they did more business in the first quarter of 1937 than in the first quarter of 1936.

In 1936 they financed 0.8 per cent more new cars than in 1929, 42.3 per cent more used cars, and altogether purchased retail paper to the amount of 6.1 per cent more in value. Moreover, their wholesale financing business in 1936 was 151.4 per cent greater than in 1929.

Was this dangerous? Have these financial writers adopted the New Deal doctrine that bigness in business is badness? If the stock market crash in 1929 was due to the large volume of automobile financing, then, perhaps, the present volume is dangerous. Possibly if the 8,500 institutions which closed their doors in the years 1929 to 1933, inclusive, had been finance companies instead of banks there might be reason to look askance at the present volume of finance company business.

Perhaps the fear is that too many people are buying cars on the instalment plan, although no one seems to state at what point an increase in instalment selling would become dangerous. Of course, there has been an increase in instalment selling of automobiles, because there has been an increase in total selling. In 1936, 23.4 per cent more new motor vehicles were registered (i.e., sold) than in 1935, and in the first three months of 1937 21.5 per cent more were registered than in the same quarter of 1936. However, this 21.5 per cent increase in registrations was accompanied by only a 4.6 per cent increase in number of cars financed.

The irregular curve in the diagram entitled "New Cars Financed in Per Cent of Registered," depicts the quarterly variations in this ratio since the beginning of 1928, while the horizontal lines drawn through this curve show the yearly averages. In general this ratio of cars financed to cars registered has been between 40 per cent and 50 per cent, all of the annual averages except that for 1928 lying between these limits. It is evident from the diagram that the ratio was low in 1935 and high in 1936. In the first quarter of 1937 it was again low, being down to 40 per cent. It will be observed that in every year the annual average has been higher than the first-quarter figure, so that we can safely prognosticate that the average for 1937 will be above 40 per cent. Present indications certainly are, however, that it will be below the 1936 ratio.

The fluctuations in this ratio of new cars financed to new cars registered have been surprising and largely unexplainable. It was relatively high in 1934 and low in 1935, followed by a new all-time high in 1936, with a drastic drop in the first quarter of 1937. It is a natural supposition that this ratio should be a direct indicator of the changes in the percentage of instalment selling. This seems especially obvious to many people who overlook the fact that financing is not by any means the same thing as instalment selling. As a matter of fact, a very considerable fraction of the instalment sales of automobiles are not financed by the sales finance companies. Many dealers keep some or all of their own paper and collect it themselves. A substantial amount of the paper is purchased by the banks, who do not report. This has always been true, although in the past two or three years there has been an increase of this financing by banks.

That the changes in the volume of financing do not fully reflect the changes in the volume of instalment selling is sufficiently demonstrated by the two curves in the diagram entitled "Comparison of Two Ratios." The lower curve entitled "Financing Ratio" represents the changes by years in the ratio previously discussed. The upper curve entitled "Instalment Selling Ratio" represents the yearly changes in

(*Turn to page 919, please*)

March Casing Shipments Up

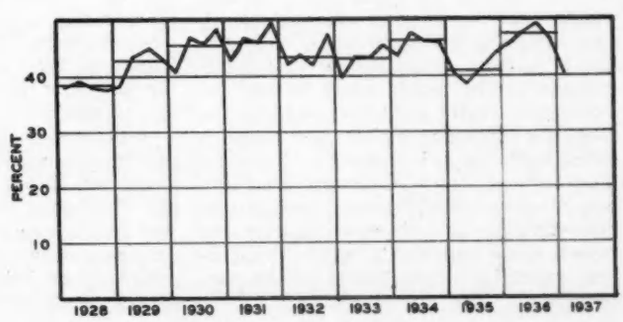
Shipments of pneumatic casings for March were put at 5,787,051 units by the Rubber Manufacturers Association, Inc. This was a gain of 32.4 per cent over shipments for February of 4,370,630 units, and of 50 per cent over shipments of 3,857,352 units for March, 1936. Production was 5,915,575 casings in March, 1937, against 5,245,894 in February and against 3,640,091 in March last year. Inventories were 12,448,167 units at the end of March, against 12,307,681 at the end of February, and against 9,086,719 at the close of March, 1936.

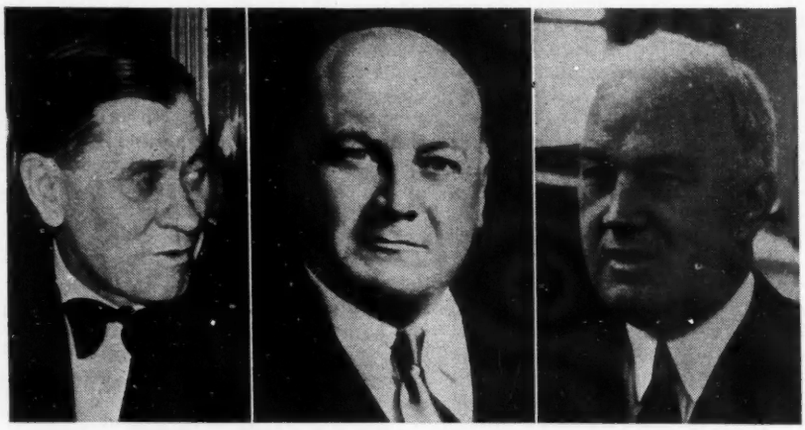
For the first three months of the year shipments were 14,666,921 casings against 10,944,126 last year, while production was 16,141,643 casings against 11,797,712 in the 1936 period.

Mallory Buys Electrad

P. R. Mallory & Co., Inc., Indianapolis, announce the purchase of the assets, good will, trade-marks, patents and patent rights of Electrad, Inc., New York City. L. A. de Rosa, chief engineer, and other key employes of Electrad, Inc., will join the Mallory organization. Plant and offices will be moved to Indianapolis.

New Cars Financed in Per Cent of Registered.





PROMOTIONS in the Chrysler organization were announced by K. T. Keller, president. Left to right are David A. Wallace, who becomes president of the Chrysler division, Joseph W. Frazer, new vice-president and director of sales and merchandising of the Chrysler division, and J. E. Fields, who takes up important executive duties for the Chrysler Corp. as a whole.

Chrysler Executives Advanced

Fields Becomes One of the Central Management Group; Wallace and Frazer Move Up In Chrysler Division

Three key executives of the Chrysler Corp. have been promoted in the program of strengthening the company's central management, it was announced by K. T. Keller, president. Policies already established will be continued.

J. E. Fields, vice-president and a director of the Chrysler Corp., and president of the Chrysler division, will assume more important duties in the executive and merchandising control of the corporation as a whole and will make his headquarters in the general offices at Detroit. David A. Wallace will become president of the Chrysler division. He has been its vice-president in charge of manufacturing at the Jefferson and Kercheval plants, and president of the Chrysler marine engine division. Joseph W. Frazer becomes vice-president and director of sales and merchandising of the Chrysler division. He has been vice-president.

"Mr. Fields," said Mr. Keller in announcing the changes, "was one of Mr. Chrysler's earliest associates in the corporation and it was under his leadership that the dealer organization which marketed the corporation's first cars was developed. He is recognized as one of the ablest and most widely known sales executives in the automobile industry. He joined Mr. Chrysler in 1922, having been engaged for many years prior to that in the machinery and cash register businesses, and with the Chalmers and Hupp automobile companies. In recent years he has devoted practically his entire time to the Chrysler division, which has made a remarkable record under his direction. The corporation is fortunate that the organization which he has built up in that division is such now that he can take a more important part in the general executive management of the corporation."

Mr. Wallace came to the Chrysler Corp. in 1929 as staff master mechanic in the office of Mr. Keller, and then became general manager. He spent his early working years in the automobile and farm tractor industries, was a captain of motor transport in the World War, and for ten years thereafter was general superintendent of Deere and Co.'s tractor plant.

Mr. Frazer was in the sales department of Chrysler Corp. when its first cars were produced in 1924, and became general sales manager of Chrysler the next year. Prior to that he had extensive sales executive experience with Packard, Pierce-Arrow and General Motors.

Withrow Hits Car Prices

Wisconsin Representative Demands Probe Action

Rising on the floor of the House Tuesday, Representative Gardner Withrow of Wisconsin, discussed his resolution directing the Federal Trade Commission to investigate the causes "for the high prices of automobiles and their accessories," and took a crack at manufacturers. He said that some retail dealers in Wisconsin are losing $7.10 on every car sold while producers are "reaping millions" in profits annually. He declared that manufacturers held short-term contracts over the heads of retail dealers as clubs.

"The result is that 25 per cent of the dealers are being forced out of business," Withrow declared.

In demanding action on his resolution Withrow said that there is no doubt but that transactions between manufacturers and dealers are interstate commerce in character, giving the Federal Government jurisdiction over them. Mr. Withrow has asked for an appropriation of $75,000 for the Federal Trade Commission while Representative Sauthoff, also of Wisconsin, has introduced a resolution which likewise deals with automobile factory-dealer relations but is more limited in scope than the Withrow resolution.

The Withrow resolution in its preliminaries says that the "continued excessive costs of automobiles and their accessories is one of the contributing factors in the present economic situation" and also alleges that the "so-called excessive price of automobiles and accessories is believed to be due largely to inequities and abuses in automobile factory-dealer relations which vitally affect the consuming public."

Used Car Stocks Excessive

AUTOMOTIVE INDUSTRIES' *Survey Shows Sales Slow, Prices Unsteady; Labor Troubles Held Cause of Poor Market*

Preponderance of dealer opinion in representative cities indicates that stocks of used cars are larger than they were last December, although in some cases lower than in the peak month of March, that sales are slow and that repricing may be necessary in the near future. Labor troubles in many centers have prevented public spending for used cars, while the market for new cars has been affected by this factor, by seasonal influences and by inadequate stocks.

Where dealers reported that stocks are higher now than in March, the percentages of increase ran from 10 to 35. Increases over November-December stocks ran from 17 to 50 per cent. In some cases, of course, stocks were reported as below March levels. The figure of 12 per cent was quoted in at least one such case. Where stocks were said to be below those of December, the figure of 15 per cent was given. Dealers handling used cars exclusively reported smaller stocks and no desire to add to them.

Meanwhile, the attention factories are paying to used car disposal was taken as an indication that the situation is not considered altogether satisfactory.

Further evidence of the effort being made to move stocks of used cars is seen in the formation of the Used Car Appearance Reconditioning Institute. This organization is distributing an illustrated booklet to dealers all over the country, showing the methods it recommends for low-cost methods of improving used car appearance for faster turnover.

Another angle of the situation was a flat warning by the National Automobile Dealers Association to dealers to reduce stocks of used cars. The association said in its bulletin that the earlier introduction of new models this year is an added source of concern.

Results of a special survey of used car stocks conducted by AUTOMOTIVE INDUSTRIES within the week are as follows:

Akron, Ohio, district—Sales and inventories have both dropped sharply since April 1. Stocks were about 1800 units at the end of 1936, reached 2200 on April 1 and stood at about 1975 on June 1. Factors involved are small stocks, the unrest caused by labor troubles and closing of shops at 6:30 p.m. weekdays, noon Saturdays and all day Sundays.

Baltimore — Demand good, stocks moderate to small and lower than in March or December, 1936. Considerable advertising being done however. Interest greatest in better type used cars.

(*Turn to page 898, please*)

General Motors Attacked by FTC

Federal Trade Commission Alleges Unfair Competition in Sale of Parts and Accessories to Dealers

General Motors Corporation and General Motors Sales Corporation, of Detroit, are charged with unfair competition and practices tending to create monopoly in the sale of automobile parts, accessories and supplies, under a complaint issued June 17 by the Federal Trade Commission. The complaint alleges violation both of Section 5 of the Federal Trade Commission Act prohibiting unfair competition and of Section 3 of the Clayton Act forbidding exclusive dealing contracts.

Alleged by the commission are intimidation, oppression and coercion to compel dealers handling General Motors cars, to purchase parts, accessories and supplies for use on such cars only from General Motors subsidiaries or affiliates.

These practices are alleged to have been effective by six General Motors subsidiaries for three years prior to October, 1936, and by the General Motors Sales Corporation subsequent to that time, the sales corporation having acquired the assets of the dissolved subsidiaries, Chevrolet Motor Car Co., Buick Motor Car Co., Pontiac Motor Car Co., Olds Motor Works, Cadillac Motor Car Co., and General Motors Parts Corporation.

As a part of the alleged intimidation and compulsion, the subsidiary companies, prior to October, 1936, and General Motors Sales Corporation, subsequent to that date, are said to have shipped to dealers automobiles equipped with accessories not ordered by such dealers and to have shipped them accessories and supplies not attached to automobiles and not ordered by them. The respondents are alleged to have threatened such dealers with cancellation of their franchises authorizing them to sell General Motors cars unless they accepted and paid for such unordered accessories and supplies, and to have cancelled the franchises of certain dealers who refused to accept unordered accessories and supplies.

The practices charged are alleged to have resulted in diversion of substantial trade from competing manufacturers of accessories and supplies and in depriving them of a market for their products, thus tending unduly to hinder competition and create a monopoly in General Motors in the accessory and supply business.

Under the charge of violating Section 3, the exclusive dealing section of the Clayton Act, the respondents are alleged to have made sales and contracts for the sale of automobile parts on the condition, agreement and understanding that purchasers thereof would not deal in automobile parts made by competitors of General Motors, the effect of this arrangement allegedly having been to substantially lessen competition or tend to create monopoly. Such exclusive sale and contract arrangements were allegedly entered into by the six subsidiaries prior to Oct. 23, 1936, the date of their dissolution, and by the Sales Corporation subsequent to that time.

The respondents were allowed 20 days in which to file answers to the charges.

R. W. GRIFFITHS, works manager of the Briggs & Stratton Corp., Milwaukee, maker of automotive locks and other hardware, has been elected vice-president in charge of manufacturing. Edward V. Oehler, general sales manager, has been elected vice-president in charge of sales.

GEORGE S. WHYTE, one of the founders of the Macwhyte Co., Kenosha, Wis., manufacturer of wire rope and cable for automotive, aircraft and other uses, has been elected to the newly created office of chairman of the board.

PHILIP P. EDWARDS, former Milwaukee banker and for the last five years vice-president of Kearney & Trecker Corp., Milwaukee, manufacturer of milling machines and other machine tools, has resigned to join the Ingersoll Milling Machine Co., Rockford, Ill., in an executive capacity.

H. C. MOUGEY, chief chemist and assistant technical director, research laboratories division, General Motors Corp., has been nominated as a member of the executive committee of the American Society for Testing Materials.

S. F. DUPREE, JR., president of All Metal Universal Joint Co., Cleveland, will take charge of the Bendix automotive division in southern California under the direction of Palmer Nichols, general manager of both the automotive and aircraft division.

WALTER P. CHRYSLER, with Boyden Sparkes, has written his autobiography, the first instalment of which is appearing in the June 19 *Saturday Evening Post*.

A. L. MARTINEK has been appointed chief engineer of the Delta Electric Co. of Marion, Ind. He succeeds L. M. Wiley, resigned.

FREDERIC G. DONNER, assistant treasurer, has been appointed general assistant treasurer of General Motors Corporation.

Truck Sales Reach New Peaks

April Registrations

New Truck Registrations

	April 1937	March 1937	April 1936	Four Months 1937	Four Months 1936	Per Cent Change, 4 Months 1937 over 1936	Per Cent of Total Four Months 1937	Per Cent of Total Four Months 1936
Ford	22,897	20,839	18,493	76,740	61,493	+ 25.0	35.27	30.53
Chevrolet	22,709	17,164	23,323	62,174	72,936	− 14.6	28.57	36.21
International	6,894	5,820	7,306	24,214	21,811	+ 11.0	11.13	10.83
Dodge	4,090	6,498	6,817	19,395	27,331	− 29.1	8.91	13.57
G. M. C.	4,815	4,201	2,733	14,887	5,470	+173.0	6.84	2.72
Plymouth	1,203	1,140	293	3,273	905	+261.0	1.50	.45
Diamond T	916	849	784	3,230	2,423	+ 33.4	1.48	1.20
White	662	566	566	2,074	1,626	+ 27.5	.95	.81
Mack	594	480	289	1,827	670	+173.0	.84	.33
Terraplane	516	547	219	1,709	513	+233.0	.79	.25
Studebaker	725	478	327	1,594	825	+ 93.0	.73	.41
Reo	394	495	379	1,560	1,199	+ 30.0	.72	.60
Federal	258	241	271	912	869	+ 5.0	.42	.43
Autocar	228	179	121	649	341	+ 90.1	.30	.17
Indiana	157	89	134	542	452	+ 20.0	.25	.22
Brockway	184	140	179	541	488	+ 11.0	.25	.24
Stewart	121	149	112	463	332	+ 39.3	.21	.16
Divco	116	83	164	373	314	+ 18.5	.17	.16
Willys-Overland	107	76	205	365	668	− 45.3	.17	.33
Stutz Pack-Age-Car	39	44	....	196	....	....	.10	....
F. W. D.	34	32	31	156	135	+ 15.5	.07	.07
Sterling	47	23	21	125	50	+150.0	.06	.02
Kenworth	9	28	....	48	....	....	.02	....
Schacht	8	10	....	28	....	....	.01	....
Miscellaneous	161	120	187	524	594	− 11.7	.24	.29
Total	67,884	60,291	64,956	217,599	201,445	+ 8.0	100.00	100.00

Business in Brief

Written by the Guaranty Trust Co., New York

Activity Drops

General business activity declined sharply during the week ended June 5. The business index compiled by the "Journal of Commerce" stood at 96.7, as compared with 105.7 for the preceding week and 91.0 a year ago. The recession was led by car loadings, steel operations, and automotive activity. The current decline in business is attributed to strikes in the steel industry and to the Memorial Day holiday. Weakness continued in commodity prices. Many industrialists are uncertain regarding the outlook for the summer and fall, and are hesitant in making future commitments.

The outlook for agriculture improved last week, especially in the interior of the country and the Midwestern States. The weather was unusually cold between the Mississippi River and the Rocky Mountains and unusually warm in the East and the Far Northwest. There was sufficient rain for present needs in most sections of the country.

Loadings Smaller

Railway freight loadings during the week ended June 5 totaled 692,140 cars, which marks a decline of 102,715 cars below those in the preceding week, a fall of 3704 cars below those a year ago, but an increase of 62,428 cars above those two years ago.

Production of electricity by the electric light and power industry in the United States during the week ended June 5 was 10.9 per cent above that in the corresponding period last year.

Lumber production during the week ended May 29 was 83 per cent of the 1929 weekly average. New orders were slightly below those in the preceding week but were 9 per cent above those a year ago. Shipments and production were at about the same levels as in the preceding week but were about 20 per cent above those a year ago.

Fisher's Index

Professor Fisher's index of wholesale commodity prices for the week ended June 12 stood at 92.0, as compared with 92.6 the week before and 93.3 two weeks before.

The consolidated statement of the Federal Reserve banks for the week ended June 9 showed a decline of $3,000,000 in holdings of discounted bills. Holdings of bills bought in the open market and of government securities remained unchanged. Money in circulation declined $52,000,000, and the monetary gold stock rose $91,000,000.

Details of Asakawa Diesel

More details of the much-discussed Asakawa Diesel engine, designed by Dr. Gompachi Asakawa of the Tokyo Engineering College, have become known from a paper contributed by the designer to the Journal of the Society of Mechanical Engineers of Japan.

The outstanding feature of the engine is that the crankshaft is cast, steel pipes for conducting lubricant to the crankpins being set into the molds. It is claimed that the engine, which has a rating of 32 hp., may be marketed at 2500 yen ($715) with a comfortable margin. Its specific fuel consumption is 0.572 lb. per hp-hr. The engine is of the precombustion-chamber type and fuel is injected at a pressure not exceeding 1800 lb. per sq. in. Owing to the fact that patents on it are pending in all the principal industrial countries, details of the fuel injection system cannot be given at the present time, but this is said to be another economy feature, as the production cost of the injection pump is only $29. It has a plunger diameter of 6 mm. (0.24 in.) and quantity control is by a rack and pinion. The engine works with a compression ratio of 20:1. It is of four-cylinder design, of 3-9/16-in. bore by 4¾-in. stroke, and develops its rated output at 2000 r.p.m. Its speed limits are 500 and 2400 r.p.m. and the weight is given as 748 lb. or about 23 lb. per hp.

Exports to Canada Gain

An outstanding increase amounting to $3,331,000 occurred in exports from the United States into Canada of automobiles and parts, taken as a group, in 1936 over 1935, according to an analysis of Canadian-American trade during the first year under the reciprocal trade agreement. The analysis was prepared by an interdepartmental committee consisting of representatives of the Department of State, Commerce and Agriculture and of the Tariff Commission.

Shipments of automobiles and parts into Canada during 1936 were valued at $27,393,000 compared with $24,062,000 in 1935. Exports of diesel engines and parts were valued at $564,000 and $374,000, respectively. Exports of aircraft and parts, including engines in 1936 were valued at $795,000 compared with $422,000 in 1935.

Welding Fund Program

Dr. Dreese Explains Awards for Automotive Papers

A primary object of the Lincoln Arc Welding Foundation is to encourage study of automotive products now built by some other method so that electric welding may be used in construction, stated Dr. E. E. Dreese, chairman of the board of trustees and of the jury of awards, clarifying the conditions surrounding the program of Foundation awards for the best papers on the use of electric welding.

The Foundation is offering $14,200 in 24 awards for the best automotive papers out of the total of $200,000 available for winning papers in several divisions of the field. In addition to the exclusive automotive awards, automotive papers may win four other awards totaling $26,000 and the grand prize of $13,700.

"The idea expressed in letters and reports from the automotive field, that the opportunities of the Lincoln Foundation's Automotive Awards are available only to individuals familiar with electric welding and its use, is entirely erroneous," states Dr. Dreese. "Although a definite object of the awards is to urge automotive engineers, designers and production managers to study automotive products which are now partially welded so that electric welding may be applied more extensively, the primary object of the Fund is to encourage study of automotive products now built by some other method so that electric welding may be used in construction.

"Ample time is allowed by the duration of the Foundation award program —closing June 1, 1938—to permit engineers to acquire sufficient knowledge of the principles of arc welded construction to apply the method in redesign. To be suitable as subject matter for a paper, it is not necessary that the automotive product be built entirely by arc welding. The rules of the Foundation specifically state that 'the machine, structure, building, manufactured or fabricated product may be designed either in whole or in part for the use of arc welding'."

. . . slants

SOUTH AMERICAN CROSSING—*First automobile crossing of the South American continent, a trip of 7700 miles in 67 days from Buenos Aires to Caracas, has been successfully completed. The route covered the pampas on the banks of the Rio de la Plata, the undergrowth of the Chaco, the tablelands of Bolivia, the jungles and seacoast of Peru, the mountains of Ecuador and the oil lands of Venezuela. The car used was a Ford 85 station wagon. The explorer was Hubert Carton de Wiart.*

FISHERMEN'S CHOICE—*Newfoundland automobile enthusiasts bought 373 new cars last year. Surprising was the small number of British makes. Vauxhall was represented with one car. Morris five and Austin three. Bulk of the sales were in low priced cars. Chevrolet led with 98 cars, followed by Ford with 63 (not designated as to source, British or American), LaFayette with 37 and Plymouth with 35.*

PONY RIDES—*One way to hold the interest of parents while showing them used cars is to keep the children from being too much in the way. A Buick distributor in Saginaw provides a free pony ride for each youngster accompanied by his parents. He has twenty ponies. Next door is a gasoline station where the idea originated. Sales curves of both are said to have risen.*

TREES—*Over 50,000,000 rubber trees are needed to produce the 75,000 to 80,000 long tons of crude rubber used annually by the B. F. Goodrich Co. An average tree produces between three and four pounds of dry rubber a year.*

The total annual output of four or five trees is needed for each tire on present average automotive equipment.

WOMEN ALSO DRIVE—*Four women set 15 international class records and ten world records, driving 10 days in a French-built Ford V8. They averaged 87.09 m.p.h. for the 20,000 miles covered and 88.29 m.p.h. for 20,000 kilometers. The Automobile Club of France supervised the run, made on the Monthlery track. It was not guaranteed that the car was a stock model. Stock car records have no standing in Europe.*

DEPRECIATION — *Cost of using a horse on an average farm includes the item of depeciation, calculated at $8.37 a year, according to a tabulation of costs in "Tractor Farming," published by the International Harvester Co. Taxes are put at 65 cents a year and insurance at 24 cents. With other costs, the total year's expense of maintaining a horse is put at $118.70 or $1.46 a day for the 81 average days each horse works.*

Motor Scooter Developed

(*Continued from page 892*)

gasoline filter, and ignition is by a Wico magneto. The drive is by a steel gear and chain. A contracting type brake acts on a drum on the rear wheel. All mechanical parts are enclosed in the rear fender. Fuel tank, seat support with streamlined tail light and cross member are cast of aluminum alloy. Both wheels are steel disks, cadmium-plated for rust protection, and mounted on ball bearings with Zerk pressure lubrication. They carry Goodyear 12 x 3.00 balloon tires. A specially designed headlight is built into the handlebar and is controlled by the same switch as the tail light built into the rear fender. Speed control is by means of the handlebar grip.

Car Sales Indicator Up

Estimates on new passenger car sales in the United States in May indicate that the total for the month may exceed April sales. The R. L. Polk Company report on registrations issued today estimates May sales at 395,000, compared with April's total of 385,000. The Polk estimate is based on returns from 12 states. Sales in those 12 states in May totaled 62,371.

Truck and commercial car sales for May are estimated at 63,000. Sales in the 15 states reporting registrations for May total 14,160, which is 6.85 per cent ahead of the same month last year and minus 11.23 per cent compared to April sales.

Compilation of April truck sales, just completed, discloses total sales of 67,884 by far the best sales month in truck history.

GM Stockholders Increase

The total number of General Motors Corp. common and preferred stockholders for the second quarter of 1937 was 359,630 compared with 358,080 for the first quarter of 1937 and with 345,265 for the second quarter of 1936.

There were 339,130 holders of common stock and the balance of 20,500 represents holders of preferred stock. These figures compare with 337,620 common stockholders and 20,460 preferred for the first quarter of 1937.

Automotive Metal Markets

Strikes Seen Likely to Prevent Any Price Reductions Which the Steel Industry Might Have Made for Fall

It is now clearly recognized in the steel market that the losses incurred by strike-affected producers will prove an additional obstacle in the way of any downward price revision that market conditions otherwise might have made a logical development.

In the long run the ultimate consumer pays the lion's share of strike bills, but the immediate burden devolves upon those who buy steel and other materials for conversion into consumers' goods. Those who are giving any thought to fourth-quarter prices therefore, are reconciled to the set-back to hopes that the price trend would before long turn in buyers' favor.

How the competitive situation in the market for light-rolled products will shape up as the result of the uneven volume of business coming to producers not affected by the CIO warfare and those that are, is a matter for conjecture. The immediate policy of the more fortunately situated steel manufacturers is to refrain from even the semblance of wanting to take advantage of the plight of the others.

Some of the arguments put forth by CIO publicity sources to impress the man in the street are taking on the tinge of farce-comedy. The reproaches made to the leading "independent" for importing much of its ore needs from Cuba and other countries are a case in point. Aside from the metallurgical considerations involved in this, supplementing the domestic ore supply by importations conserves the ore reserve of the United States, an economic advantage which, in the light of the recent epidemic of jitters over our scrap exports, is self-evident. Iron mine labor has never suffered from this and steel consumers have benefited indirectly.

Markets for non-ferrous metals have quieted down. Europe's appetite for copper has lessened to a point where the export price has dipped sharply below the domestic parity, weakening the home market's undertone. Renewal of export quotas by the International Tin Committee, sittting at The Hague, at 110 per cent of normal tonnages for the third quarter has eased the situation in the market for that metal.

Leading producers of cadmium have advanced their prices 40 cents a pound to $1.60 for sticks, bars and patented shapes. In the "outside" market as high as $2 was paid this week.

Pig Iron—Automotive foundries are not very prominent on the buying side. Some round tonnages have been bought for the third quarter by tractor manufacturers. Prices rule steady.

Aluminum—The market generally is marking time, with no change in prices noted.

Copper—Some second hand lots of electrolytic were reported to be waiting for buyers at the beginning of the week at 13½ cents. That was also the price for the red metal in foreign markets on Monday, but on Tuesday 13¼ cents became the nominal export price level. The home price remained at 14 cents.

Firestone to Make "Air Springs"

One of the principal products of the new Firestone Tire & Rubber plant at Riverview, Mich., will be the recently developed "air spring" which embodies a new principle of automobile suspension by providing rubber cushions inflated with air to replace metal springs. The new plant will also produce rims for original equipment.

"The new air spring is designed to replace the conventional type of steel spring with a valve-controlled air cushion in the form of a rubber bellows. It is expected to become an important division of the company's business" states the Firestone Company.

The new air spring was first introduced before members of the Society of Automotive Engineers in January, 1936, by R. W. Brown, Firetsone research engineer. The rubber fabric bellows can be inflated with air to carry any desired load, and operates automatically in conjunction with an air reservoir by means of a pendulum shock absorption valve. Tests, company officials claim, show that the air spring climinates body roll in the automobile, erases the effect of road irregularities, controls softness of riding qualities and produces quieter operation of the car.

40 Years Ago

with the ancestors of AUTOMOTIVE INDUSTRIES

"On Motor Traffic"

A paper by Sir David Salomons, President of the Self-Propelled Vehicle Association (England)

There are several points in connection with steam carriages which cannot be overrated, and greatly to be appreciated, by those who have been in the habit of using petroleum-driven motors. The chief one is that the crawling process up a hill is dispensed with, and 12 miles an hour up the steepest hill which horses and carriages at present climb, can be obtained without an effort. Secondly, when stopping and starting in the traffic, the engine is stopped and started as would be done in the case of a horse . . . There are no valves to grind, no cylinders to clean, no inflammable material to store at home or carry when on a trip, no unpleasant smell is produced, there is absolute freedom from vibration, no chance of breakdown when least expected, no accumulator to charge, or platinum points to be renewed, no ignition lamps and tubes requiring attention and occasional renewal, all repairs that may become necessary at any time, the carriage builder, or even the village smith, can carry out.

From *The Horseless Age*, June, 1897.

Used Car Stocks Excessive

(*Continued from page 895*)

Birmingham, Ala.—Stocks 20 to 33 1/3 per cent over March, but 15 per cent under December, 1936. Used truck stocks above March.

St. Louis—Stocks high for this time of year, but below March and December levels. Used truck stocks have risen latterly. Car stocks dropping now. Stocks April 30 were 3858 units against 3447 a year earlier.

Austin, Tex.—Stocks 25 per cent over March and December levels. Dealers in used cars exclusively reported sharply lower stocks with the decline as much as 35 per cent in several cases. Fear lower prices.

Toledo—Stocks 10 to 20 per cent over March and December. Sales have been slowing down. Some dealers finding used car stocks a curb on new car operations. Break in prices reported imminent.

Boston, Mass.—Stocks lower than in March and much smaller than in December. Slowing in new car sales in May cut into used car stocks. Used cars move well.

Huntington, Ind.—Sales at low ebb, prices 15 per cent under last December. Demand centers on 1936 or 1931 and 1932 cars. Dealers junking more trade-ins than last year. Situation considered bad.

Washington, D. C.—Stocks not excessive, reported 17 per cent over November, 1936, against increase of 21 per cent in March over November.

Milwaukee — Majority of dealers overloaded, turnover rising to 45 days from usual 20-day rate. Stocks 35 per cent over March, 50 per cent over last December. Salesmen claim they cannot make a living from used car sales.

South Bend, Ind.—Sales and prices both poor. Stocks about the same as in winter, majority of dealers report. Labor troubles held cause of bad business.

Indianapolis—Stocks will probably be completely repriced if new car production again reaches large volume. Some dealers overloaded but a few others need "clean" used cars. Stocks slightly lower than in March but a little over December, 1936, totals. Junking proceeding more rapidly.

Cleveland—Stocks extremely heavy, down only 12 per cent from March and 35 per cent over last December. Dealers say public is waiting for industrial disorders to be settled. They are tightening up on allowances. Market called unhealthy.

Wilmington, Del.—Stocks and sales at peak levels. Demand best for small cars.

Los Angeles—Stocks 12½ to 35 per cent lower than in March, with March in majority of cases well above December, the then increase ranging from 17 to 23 per cent. Used car dealers only reported stocks at 72,500 cars June 15 against 81,000, March 15, and against 90,000, Dec. 15, 1936. Dealers reported stocks still excessive for this time of year, with sales poor due to country-wide labor troubles. Both new and used car sales held affected. One dealer said factory sales drive on used cars brought results.

New York—A survey of ten dealers showed total stocks of 921 units at present, against 1428 March 15 and against 1988 Dec. 15, 1936. Dealers said the market was in satisfactory condition, although they would prefer to reduce stocks even further than they have been able to do. In only one case were stocks near December and March levels.

Retail Volume Large

(*Continued from page 891*)

of 469,000 vehicles, or nearly 60 per cent in excess of the June average for the past 10 years.

Cadillac LaSalle retail deliveries for the first 10 days of June showed a 129 per cent increase over the similar period of a year ago.

Domestic retail sales of Buick cars during the first 10 days of June totaled 7807 units. This compares with 6508 during first 10 days of May and 4768 during the corresponding period of June, 1936.

Studebaker reported the sale of 2921 passenger cars and trucks in the first 10 days of June, compared with 2190 in the same period of 1936, an increase of 33 per cent. This brings sales from Jan. 1 to June 10 to 49,420 compared with 42,201 to June 10, 1936.

Pontiac retail sales during May were 25,839 which is the third successive month that sales have topped the 25,000 mark.

Original production schedules of Willys are being revised to 80,000 units for the year from 60,000.

TOY CAR models of the Toyota and Lincoln - Zephyr are being made in Japan. The "proving ground" is at the right.

Hupp Shows New Series

Steel Bodies Newly Styled Previewed for 1938

Hupmobile's program for 1937, featuring a new merchandising set-up, was revealed briefly to a small group of representatives of the press this week. In all probability, the 1938 line, comprising a six and an eight, will be publicly announced early in August. Prices are not available at this writing but the impression is that the six will be located in the $1,000 price bracket.

The 1938 Hupmobiles will be smartly styled in the modern fashion, judging by the models shown. All steel bodies with steel roof, wider and roomier than ever before, will be featured. These bodies are entirely new and made from new dies. Hoods will raise at the front, alligator style.

Mechanically, the new line will continue the time-tried Hupp chassis features and engines with detail improvements and changes in manifolding and carburetion demanded in current practice. The six will have an engine rated about 101 hp.; the eight, 120 hp. The six will be mounted on 122 in. wheelbase while the eight will have a 125 in. chassis. Overdrive will be optional equipment.

So far as interior styling is concerned, the interesting feature is a new instrument panel built around a massive steel stamping with doors and facing of molded plastic with chromium strips. Fisher no-draft ventilation will be standard.

On the exterior, the headlamps are faired into and are a part of the fixed hood side panel, carrying out the horizontal chromium strips on the hood louvers. At the rear, the tail lamps are faired into the body side panels at the belt line with a special license plate bracket with an individual lamp on the luggage compartment door. Both cars will be available with plain back or trunk back.

Hardware, radiator ornament, and bumpers are new and represent unique styling harmonizing with the general lines of the car. Front bumpers will have four vertical bumper guards, two of them being spaced closely about the radiator grille and made unusually massive to offer adequate protection at this point.

Ward's Takes Over Cram's

All the assets of Cram's Automotive Reports, Inc., Detroit Associates, Inc., and Gram's Reports, Inc., Michigan corporations, have been sold to Ward's Reports, Inc., a Michigan corporation, by the receiver for the three concerns under order of the circuit court for Wayne County.

The court issued a notice which said that Ward's Reports, Inc., is required by the terms of the sale to service all existing subscribers of Cram's Automotive Reports with regular delivery of Ward's Automotive Reports until Cram's subscriptions expire.

A new illustrated catalog of **detachable instruments** for indoor and outdoor service has been published by the Westinghouse Electric & Manufacturing Co. It is section 43-600.*

The Buick division of General Motors Corp. has issued a booklet listing over 2800 **dealer service stations.** They are arranged by cities and states. A million copies are being distributed.*

Sixth edition of the **Asphalt** Pocket Reference for Highway Engineers has been published by the Asphalt Institute.*

The Carboloy Co., Inc., has issued a new 37-page catalog of prices, descriptions and drawings of **blanks and tools.***

Caterpillar Tractor Co. shows its **products at work** in a new booklet, known as Form 4194.*

General Armature Corp. offers a **leaflet** discussing its products.*

Bausch & Lomb has issued a **catalog,** D 22, entitled "Optical Aids in the Metal Working Industries."*

*Obtainable from editorial department, Automotive Industries. Address Chestnut and 56th Sts., Philadelphia.

Enters Air Conditioning

The new year-round low-priced air conditioning unit which the Central Manufacturing division of the Auburn Automobile Company has had under development for some time will be ready for the market early in June. The unit will make possible natural air conditioning for homes at an initial cost of around $250.

Seek to End Strikes

(*Continued from page 891*)

of the Department of Labor. The board will have no powers to subpoena but has apparently the assurance of cooperation by both companies and the union. It will be a fact-finding body, and may also serve as arbitrater if the disputing parties agree to have it do so. Headquarters will be in Cleveland and the board will report weekly to the Secretary of Labor.

The labor situation in General Motors plants appeared to be easing by midweek. Employes of the Ternstedt Manufacturing division voted Wednesday to return to work under an agreement which provides for change-over from piece-work to hourly rate wage scales by June 28. The 12,000 Ternstedt employes have been on strikes since June 7.

The Chevrolet Gray Iron Foundry in Saginaw which has been closed from time to time during the past few weeks, resumed operations Wednesday night after a vote of the workers on a settlement. The Chevrolet and Fisher Body plants at Baltimore also voted Tuesday to return to work. Stoppage of operations at the foundry had caused several other Chevrolet units to close for lack of materials. Among these were various units in Flint, Bay City, and the gear and axle plant in Detroit which employs 8000 men. Some time was lost by the assembly branches throughout the country but all were in operation Wednesday this week. The latest strike is at the Buffalo plant of Fisher Body Co. A settlement was reported to have been made but the strike was still on Thursday. Chevrolet's Muncie, Indiana, plant, employing 1400 men, has been closed and will not reopen until materials are available from the steel industry.

The Cleveland Fisher Body plant closed Tuesday because of an oversupply of stampings. It has built up a large bank of door panels due to the closing of other General Motors plants. The closing, which will probably last not less than a week, affects 6500.

A factional fight within the union was in prospect at Flint where primary elections are being held by the UAW local. It is reported that Homer Martin has called a special session of the union's executive board at which he would demand support for the ouster of Robert C. Travis and Roy Reuther, Flint organizers.

At South Bend, Ind., the UAW local No. 9 voted to avert a pending strike at the Bendix plant. The ten boiler room workers who were transferred because of the installation of automatic boilers, causing the controversy, were given other jobs at the same wage and two were returned to their old jobs.

Champion Spark Plug Company's four-week strike in Detroit was ended with an agreement that sent 725 employes back to work June 16.

Packard Motor Car Company resumed operations in all divisions June 15 after a strike in its stamping division had forced the assembly lines of the two small cars to suspend operations June 4. The strike also had closed the tool and die division where the settlement provides for new wage agreements.

As one new Ford union was being formed, another union disbanded. According to Harry Bennett, personnel director of the Ford Motor Co., the Ford Brotherhood of America, Inc., organized June 3, agreed to disband. This union was started by a group of Ford employes who claimed to have been with the company from 10 to 20 years. The UAW had charged that the organization was a company union, but the Ford company, according to Bennett, does not favor organization of its employes by any one. Bennett has also asked the three officers of the recently formed Workers Council for Social Justice, Inc., to return to work or be discharged. The union was announced in full page advertisements on June 13.

Bennett also stated that Ford would cease production during the summer inventory period the last two weeks in July but would hold employment at about 20,000 men out of a full force of 123,000 at Rouge and branches. He said the plans were usual and had no bearing on the labor situation.

The foundry of the Electric Auto-Lite Co. at Fostoria, Ohio, closed Tuesday when UAW pickets surrounded the plant. The CIO group lost a plant election conducted under the auspices of the National Labor Relations Board. Victor was the Fostoria Foundry Workers Union, a local independent. The vote was 248 to 237. W. W. Sherman, general manager, posted a notice that said no discrimination would be shown toward members of the minority group.

Fisher Body to Expand

Plans Trenton, N. J. Factory; Will Improve Others

Details of a $15,000,000 expansion program for the Fisher Body division of General Motors Corp. were announced June 17 by E. F. Fisher, general manager of the division.

The major part of the program includes construction of a new plant for the Ternstedt Manufacturing division at Trenton, N. J., and the construction of a new press shop at Flint, Mich. The latter has been previously announced.

The program also includes an addition to the metal shop at Grand Rapids, Mich., and rearrangement of the plant at Cleveland. The plans also include additional equipment and improvement of many other Fisher Body plants in preparation for the 1938 model season.

The Trenton plant will be erected on a 60-acre plot which has just been acquired, and will be used for the manufacture of hardware and metal interior trim parts for closed automobile bodies. The activity will be known as the Ternstedt Trenton division of General Motors.

The planned building at Trenton will consist of about 900,000 sq. ft. of floor space. The front of the building will be two stories and largely used for offices. A further section extending the entire length of the building will also be two stories and will be used for finishing processes. This area will be air conditioned.

It is planned that the production of this plant will be distributed to various Fisher Body and General Motors plants located in the East, such as Tarrytown, N. Y., Baltimore, Md., Bloomfield and Linden, N. J., and possibly Atlanta, Ga.

It is anticipated that the total employment will reach 3000 people of which a large percentage will be women.

The new plant will be operated as a separate unit under the general supervision of the Fisher Body division and the operation officials of the Ternstedt division, Detroit. These officials are S. E. Skinner, general manager; E. W. Sturgeon, general production manager, and E. J. Hanson, general works manager.

The Cleveland program calls for the provision of additional loading facilities and of additional space for the die shop. It also includes rearrangement of the employment office and hospital and cafeteria facilities.

Robert R. Keith

Robert R. Keith, general works manager of the J. I. Case Co., died suddenly on June 12, at the age of 58.

Before he joined the Case company in 1929, he was in charge of motor truck, coach and all automotive transportation engineering of the International Harvester Co., with which company he had been for eight years. Prior to that he was tractor works and plant manager of the Moline Plow Co. works and plant manager of the Holt Co. at Peoria, and assistant superintendent and plant manager of the Fairbanks Morse Co. at Three Rivers.

Mr. Keith was an active member of the Society of Society of Automotive Engineers, of which he became a member in 1922. In 1936 he was a member of the society's production activity committee and served on a number of other committees in earlier years.

Mr. Keith received the degree of B.S. in M.E. from Iowa State College in 1902.

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34 States Give Plate Grace

Thirty-four states now give motorists periods of grace of from one to three months in renewing their license plates and through that courtesy are collecting many millions of dollars of additional gasoline taxes annually, according to the American Petroleum Institute. Five states joined the deferred registration ranks this year.

Prior to 1929, when the major source of automotive tax revenue was registration fees, it was not so important whether a motorist renewed his license plates promptly or kept his car idle several months. In most states today, however, gasoline taxes are the chief source of automotive income, and if 10 per cent or more of the motor vehicles idle during the first months of the year, substantial losses in tax revenues result.

AUTOMOTIVE INDUSTRIES

Looking Ahead

SANRINSHA (tricycle to you) was a new word to us too, so we read with unusual interest a ms. submitted by our Tokyo correspondent, Herbert Leopold, telling how Japanese manufacturers have made an honest commercial vehicle out of motorized tricycles. The story is yours—in next week's issue.

ONLY FIVE readers of *Automotive Industries* will probably be able to understand a mathematical analys's of turbo torque converters by Joseph Jandasek, which appears in next week's issue. The figure is a curbstone estimate by our technical staff, which hopes it will be wrong—and is willing to present a year's subscription to the magazine to the writer of the *sixth* letter which understands Mr. Jandasek's article well enough to take issue with it.

Bendix Expands on Coast

Another move in the expansion program of the Bendix Aviation Corporation was announced by Vincent Bendix. The latest development is centered in California.

Mr. Bendix stated that a 20-year lease had just been taken upon two large hangars at Burbank Airport, Los Angeles. One of these hangars is already operated by Bendix Aviation through its subsidiary, Pacific Air Motor Corporation.

"We are enlarging our aircraft and automotive operations in California," said Mr. Bendix. "Both plant facilities and personnel are being expanded. In addition to the two hangars we have just taken an option on a large piece of adjoining vacant property on Burbank Airport for possible future expansion."

Willys Forms Export Unit

Willys Export Corp., with capital of $100,000, was chartered in Toledo by officials of Willys-Overland Motors, Inc., under Ohio laws, as the export subsidiary provided for in the reorganization plan. It will be owned by the parent company.

Lycoming Backlog $600,000

The Lycoming division of The Aviation Manufacturing Corporation announced that unfilled orders on hand for Lycoming radial aircraft engines and Lycoming controllable propellers amounted to over $600,000. About half of these orders are for the U. S. Army and Navy.

Calendar of Coming Events

SHOWS

Morocco, Automobile Section, Tangier Fair, Tangier .....June
France, Automobile Section, Bordeaux Fair, Bordeaux .....June 13-28
Belgium, First International Aeronautical Salon, Brussels.....June 18-30
Fourth ASTM Exhibit of Testing Apparatus and Related Equipment, New York .....June 28-July 2
Second Winter Item Show, Automobile Accessories Association, Chicago, Aug. 9
Poland, Automobile Salon (Foire Orientale), Lwow .....Sept. 1-15
Yugoslavia, Automobile Section, Autumn Fair, Ljubljana .....Sept. 1-12
Yugoslavia, Automobile Section, Commercial Fair, Belgrade.....Sept. 11-21
France, 31st International Automobile Salon, Paris .....Oct. 7-17
Great Britain, 31st International Automobile Exposition, London....Oct. 14-23
Czechoslovakian Automobile Show, Prague .....Oct. 16-24
National Automobile Show, New York, Oct. 27-Nov. 3
Toledo, O., Automobile Show..Oct. 27-Nov. 3
Italy, 10th International Automobile Salon, Milan .....Oct. 28-Nov. 8
Boston, Mass., Automobile Show, Oct. 30-Nov. 6
Los Angeles, Cal., Automobile Show, Oct. 30-Nov. 7
San Francisco, Automobile Show, Oct. 30-Nov. 7
Cincinnati Automobile Show.Oct. 31-Nov. 6
Great Britain, 13th International Commercial Automobile Exposition (trucks and buses), London...Nov. 4-13
Chicago Automobile Show.....Nov. 6-13
Akron Automobile Show.....Nov. 6-12
Omaha Automobile Show.....Nov. 6-11
Brooklyn Automobile Show.....Nov. 6-13

Show Business

Manager of the National Automobile Show in New York is Alfred Reeves, 366 Madison Ave., N. Y. C. Inquiries concerning all matters connected with the national show should be addressed to him. AUTOMOTIVE INDUSTRIES will be pleased to furnish names and addresses of local show managers on request.

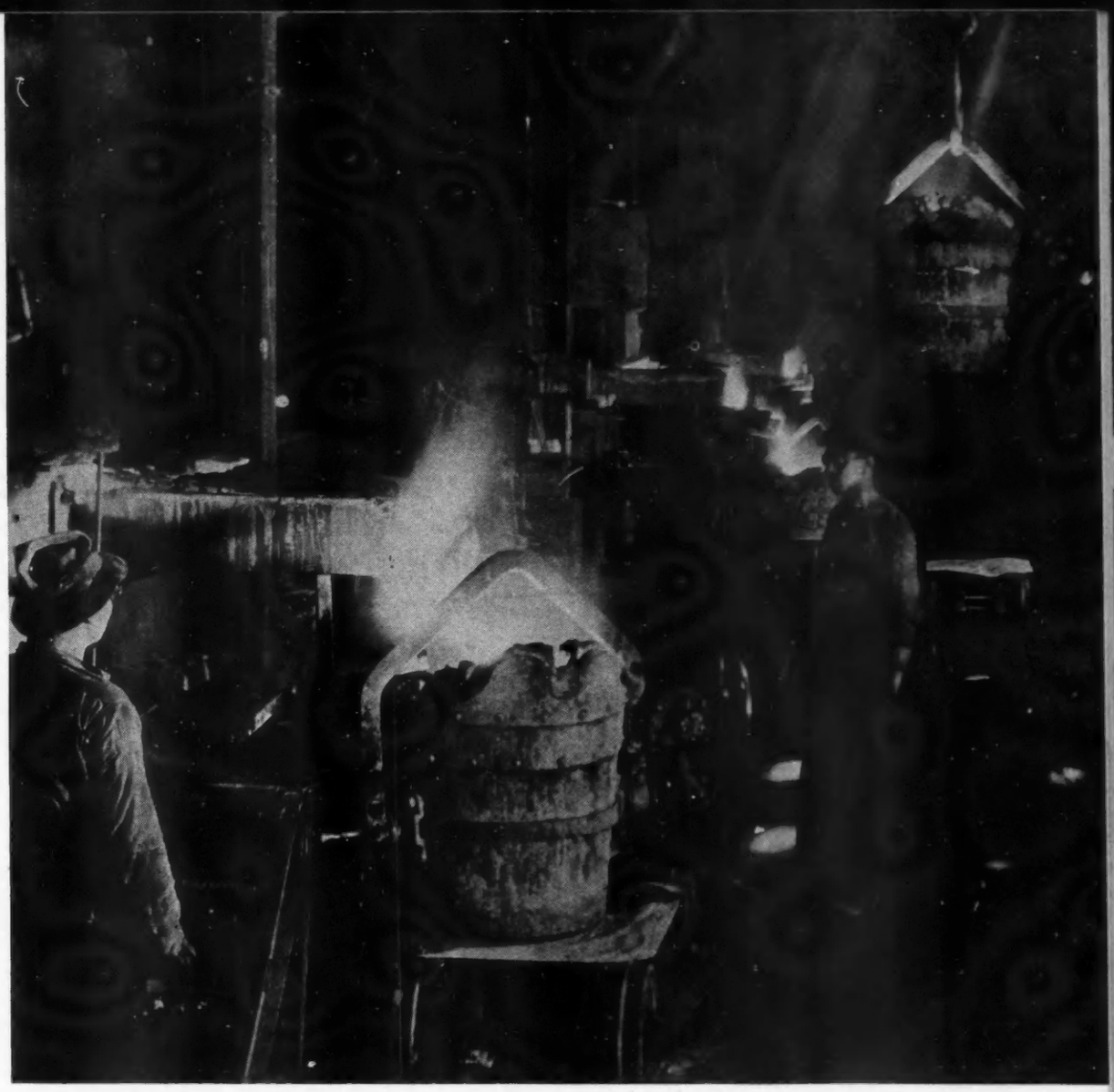
Columbus Automobile Show .....Nov. 6-12
Detroit Automobile Show.....Nov. 6-13
Motor Truck Show, 4th Annual, Newark, N. J. .....Nov. 6-12
Newark, N. J., Truck Show.....Nov. 6-12
Buffalo, N. Y., Automobile Show..Nov. 6-13
Indianapolis, Automobile Show....Nov. 6-13
Newark, N. J., Automobile Show..Nov. 6-13
Philadelphia Automobile Show....Nov. 6-13
Pittsburgh, Pa., Automobile Show.Nov. 6-13
Toronto, Ont., Automobile Show..Nov. 6-13
Great Britain, 36th Scottish International Automobile Exposition, Glasgow .....Nov. 12-20
Baltimore, Md., Automobile Show, Nov. 13-20
Cleveland, Ohio, Automobile Show, Nov. 13-20
Jersey City, N. J., Automobile Show, Nov. 15-20
Milwaukee, Wis., Automobile Show, Nov. 17-24
Springfield, Mass., Automobile Show, Nov. 14-20
St. Louis, Mo., Automobile Show.Nov. 14-21
Portland, Ore., Automobile Show.Nov. 14-21
Denver, Colo., Automobile Show, Nov. 15-20
Montreal, Que., Automobile Show, Nov. 20-27
Kansas City, Mo., Automobile Show, Nov. 27-Dec. 4

CONTESTS

31st Annual Grand Prix of the Automobile Club of France, Linas-Montlhéry .....July 4
Roosevelt Raceway, 300-Mile George Vanderbilt Cup Sweepstakes (Rain date July 5) .....July 3
National and International Soap Box Derby Finals, Akron, Ohio.....Aug. 15
Pan American Cup Race, Roosevelt Raceway .....Sept. 6
National Outboard Championship Regattas, Richmond, Va.....Sept. 18-19

CONVENTIONS AND MEETINGS

Second World Petroleum Congress, Paris, France .....June 14-19
Automotive Engine Rebuilders Association, 15th Annual Convention, Chicago .....June 21-24
American Society for Testing Materials, 40th Annual Meeting, New York, June 28-July 2
U.A.W. Annual Convention, Milwaukee, Aug. 23
American Transit Association, 56th Annual Convention, White Sulphur Springs, W. Va.....Sept. 19-23
S.A.E. Fuels and Lubricants Regional Meeting, Tulsa, Okla. ...Sept. 30-Oct. 1
S.A.E. National Aircraft Production Meeting, Los Angeles, Calif.....Oct. 7-9
S.A.E. Annual Dinner, Commodore Hotel, New York.....Oct. 28
American Petroleum Institute, 18th Annual Meeting, Stevens Hotel, Chicago .....Nov. 9-12
S.A.E. National Production Meeting, Flint, Mich. .....Dec. 8-10



Automotive Materials

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NOT since Henry Ford startled the industry by using alloy steels in motor vehicles have materials been of such tremendous importance in the automotive world. There is now a constant interchange of use between various metals and non-metallic materials and as one type seems to gain ascendancy for a particular use it is often displaced, almost overnight by a new development. With this in mind we have set out to chronicle in AUTOMOTIVE INDUSTRIES (each third issue of the month) what's going on in the field of materials.

In this issue the spotlight turns to iron and its alloys as materials for castings used in motor vehicles. About a fifth of the gray iron produced in the U. S. goes into automotive apparatus. Of the 7000 men who attended the meeting of the American Foundrymen's Association a little more than a month ago, a good proportion were connected with automotive foundries. So one may conclude that iron and its alloys, as castings, are extremely important to the automotive industry. The article which follows demonstrates that developments in this field are far from stagnant, in spite of more spectacular developments in other branches of the materials art.

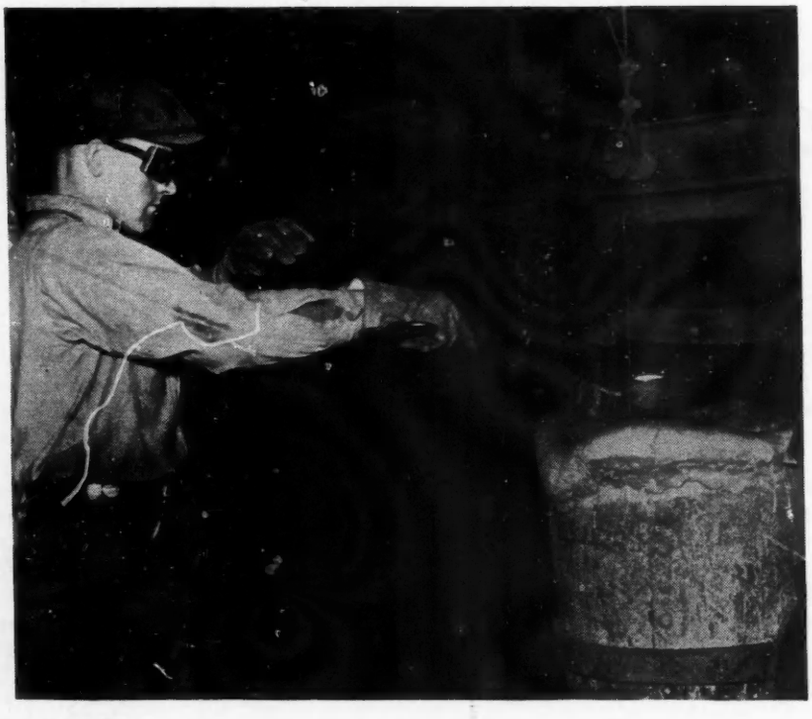
CAST IRON—

With the Automotive Industry using 19 per cent of all gray iron castings and 54 per cent of all malleable castings produced in the United States, this article should be of paramount interest to everyone connected with the manufacture of automobiles

ALTHOUGH there are not as many castings, relatively, in the modern automobile as there were in the earlier "horseless carriages" (of which even the body panels sometimes were a foundry product), castings still enter largely into the production of all types of automotive vehicles. For a long time there was a constant shift from cast to forged and drawn parts, which latter became more practical as the scale of production increased and the pro-rata cost of the dies and other production equipment required decreased in consequence. Recently, however, there has been a certain trend in the opposite direction, and a number of parts that previously were made of malleable materials are now produced from castings, or, as in the case of modern brake drums, in the form of composite drawn-and-cast constructions. As regards that most important part of the whole chassis, the engine block, no better material than cast iron has yet been found, at least not for applications where cost is an important item.

The heavier cast materials that enter into the production of automotive vehicles and tractors include the three principal cast ferrous products—cast iron, malleable cast iron, and cast steel. Of these three the first mentioned is used in by far the largest quantity. One recent writer estimates the percentage of cast iron in the average modern passenger car as between 12 and 14, on a weight basis. A good idea of the importance of the automotive industry as a consumer of cast iron can be gained also from "Facts and Figures of the Automobile Industry" (1937 ed.) according to which 19 per cent of all gray iron and 54 per cent of all malleable cast iron produced in the United States goes into automotive vehicles. Corresponding figures for cast steel are lacking, though it is safe to assume that with the recent adoption of this material for crankshafts and pistons by one of the largest manufacturers, the automotive industry now ranks also as one of the largest consumers of the products of the steel foundry.

The metallurgy of cast iron has been developed in many directions, and special grades are now available to suit almost any purpose. For some applications high mechanical strength is of importance, and cast irons are now being made with a tensile strength of close to 100,000 lb. per sq. in., or more than four times that of the ordinary grade of a quarter century ago. Nearly all of the important cast-iron automobile parts are subjected to sliding motion, and therefore to wear, and considerable progress has been made in increasing the wear-resistance of the material. Where very concentrated loads have to be supported, wear resistance is an important characteristic,



Sampling a ladle of molten metal at the Pontiac foundry to be used for tests

By P. M. Heldt

Cranes equipped with electro-magnetic lifts carry the raw metal to the furnaces

The big ladle carries the molten metal from the cupola to handle ladles

and cast iron parts are now produced with chilled surfaces that have wear resistance equal to, and even greater than that of case-hardened steel. Heat treatment with the object of refining the grain and improving the mechanical properties is applied to cast iron the same as to steel.

In many automotive parts rigidity is highly essential, but the parts must at the same time be light. The rigidity of parts of a given design depends upon the modulus of elasticity, which for the ordinary grade of cast iron is only about one-half that of steel. However, the socalled high-test grades of cast iron have a modulus of elasticity considerably above the 15,000,000 usually given for cast iron in engineering handbooks.

In certain applications the coefficient of heat expansion is of importance. This applies particularly in the case of internal combustion engines where cast iron parts have to be used at high temperatures in combination with aluminum parts. The normal copper-aluminum alloys have about twice the coefficient of heat expansion as ordinary cast iron, but high-alloy cast irons have been developed with a coefficient of heat expansion some 50 per cent greater than that of the ordinary grades, and when this is used in combination with special aluminum alloys of unusually low heat expansion, the differential-expansion difficulty practically disappears.

Another difficulty with cast iron parts subjected to high temperatures in the past has been that these parts "grow" and "creep," and that the resulting distortion may give rise to abnormally high friction and wear. This problem also has been taken in hand by the cast-iron metallurgists, and special "low-growth" grades have been developed which solve this difficulty. In some applications, particularly that to piston rings, the "springiness" or resilience of cast iron is made use of. This, of course, decreases as the temperature of the material increases. Piston rings always lose some of their resilience in service. This is partly due to wear, but loss of resilience due to the high temperatures to which the rings are exposed in service is another factor. The writer understands that some progress has been made in developing cast irons whose elastic properties are less subject to change at high temperatures than those of the ordinary grades.

All cast irons contain at least six elements, viz., iron, carbon, silicon, manganese, phosphorus and sulfur. Of these the last two enter the melting furnace with the ore and the fuel, and are generally regarded as impurities, though for certain special applications a fairly high phosphorus content is considered advantageous and specially provided for. Iron, of course, is the principal constituent and usually forms more than 90 per cent of the total by weight. Carbon is present in two different forms, as combined iron in the form of an iron carbide, and as segregated carbon in the form of graphite flakes or plates. The proportion of carbon chemically combined with the iron to the total carbon can be changed in various ways, and the mechanical properties of the material thus controlled. It can be influenced by varying the proportions of other constituents, notably that of silicon.

As long as very little silicon is present, any slight increase in its proportion adds to the strength of the iron, but all ordinary cast irons contain a percentage far beyond the range to which this rule applies. The reason for incorporating additional silicon is that it helps to form graphite and thus to reduce the proportion of combined carbon; in other words, silicon is a "graphitizer." Another graphitizer is nickel.

A study of the effects of the three minor elements in ordinary cast iron on the grain structure and the physical properties was made by Alfred Boyles at Battelle Memorial Institute, Columbus, Ohio, and was reported by him in the April issue of *Metals Technicology*. The materials tested were prepared by making additions in elemental form, using materials of reagent quality. The base metal was an iron-carbon-silicon alloy, and only the element whose effects were to be specially studied was added to this base metal. With an increase in the manganese content from 0.15 to 1.22 per cent, the Brinell hardness increased continuously from 119 to 210. The structure of the cast iron also was changed.

Four metals ranging in phosphorus content from 0.30 to 0.70 per cent all gave the same kind of structure, the phosphorus in all cases segregating into the boundaries of the cell structure. There was not much change in the graphite flakes with a change in the phosphorus content.

In contrast to phosphorus, sulfur had a very pronounced effect on the structure of the metal. As the sulfur content was raised, the graphite flakes increased to a maximum size, after which they became smaller again, and a given amount of sulfur produced a greater effect in this respect in an iron of lower carbon content. Experiments in quenching test samples showed that graphite flakes begin to form only when the eutectic begins to freeze and that as soon as the eutectic is completely frozen the flake structure is essentially complete.

The above result with respect to the effect of phosphorus is somewhat at variance with findings of other investigators, who report that this element increases the size of the graphite flakes, because it keeps the iron in a sort of pasty state during the freezing process. This difference in the results may, of course, be due to the fact that in Boyles' tests the iron contained no manganese and no sulfur. Phosphorus increases the expansion during shrinkage and decreases the density of the iron. One of the most important effects of the phosphorus is that it increases the fluidity of the iron, and where castings having large thin sections have to be poured a considerable phosphorus content is desirable. One of the bad effects of this element is that it tends to make the material brittle.

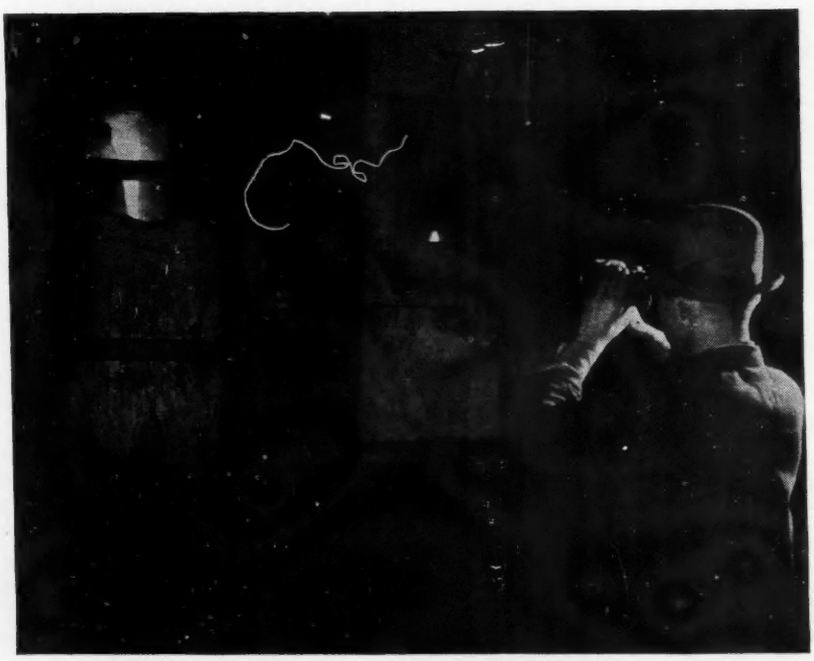
Sulfur in cast iron hampers the separation of carbon in the form of graphite, and must therefore be kept low. The sulfur is generally introduced with the fuel, and its percentage therefore increases every time iron is remelted. For this reason, the greater the proportion of scrap used in a charge the higher the sulfur content of the melt. The bad effects of sulfur can be counteracted to a certain extent by an increase in the silicon content. Manganese also overcomes the bad effects of sulfur. Sulfur combines with manganese in preference to combining with iron, and if sufficient manganese is present all of the sulfur will be bound to it, in which condition it is less harmful.

Silicon, in addition to being a graphitizer, is an excellent deoxidizer. Atmospheric oxygen is absorbed by the iron while the latter is in the molten state, and as there is a great affinity between molten iron and oxygen, iron oxides are formed, which are very objectionable, as, besides weakening the structure they have a hardening effect and impair the machining qualities. Deoxidizers are therefore added to the melt. Aluminum is an excellent deoxidizer, and it also has other beneficial effects, promoting the formation of graphite and reducing the chill. Carbon in the form of graphite is also added for this purpose.

Coming now to the alloying elements that is, metallic elements which are not found in ordinary cast iron—those now extensively used include nickel, chromium, molybdenum, vanadium, and copper.

Nickel acts as a graphitizer, and also increases the fluidity of the iron, which makes it advantageous where large housings with thin walls have to be cast. It lowers the proportion of the carbon in the eutectoid and the temperature of formation of the latter. When used in combination with chromium it increases the hardness of the cast iron and its resistance to abrasion and wear. Nickel and chromium have compensatory effects in more than one respect. Chromium hardens and embrittles the material, and unless this is compensated for by nickel, the permissible chromium content is quite limited. There is no such restriction on nickel, which is therefore always used in larger proportions. The grains in hardness and strength due to the addition of nickel and chromium are obtained without sacrifice of machining qualities, which makes these alloying elements the more valuable. Chromium tends to prevent the formation of free ferrite, which latter is especially undesirable in parts subjected to abrasion, as the ferrite has a tendency to score. Both nickel and chromium refine the grain and keep down the size of the graphite flakes.

The use of copper in automotive cast irons is of quite recent origin. Its influence has been made the subject of a special investigation by the British Cast Iron Research Association, and the following summary of the results so far obtained has been given out by J. G.



In a foundry where cylinder blocks, pistons, cylinder heads and other iron parts of an engine are cast it is necessary to maintain a constant temperature in the cupolas or else the castings will be imperfect. Checking the pouring temperature at the spout of one of the four cupolas is done by means of an optical pyrometer at the Pontiac foundries. The instrument is held to the eye and focused on the stream of hot metal. The focusing adjustment is turned until the color of the stream of metal is the same as a flash of light produced by the batteries inside the pyrometer. The reading on the scale on the side of the pyrometer is the number of degrees of heat of the metal. The instrument is accurate to 5 degrees. The observer stands at a distance of 10 feet from the stream of hot metal

Pearce, director of the Association:

"The effective solubility of copper in cast iron is just over three per cent, and up to this percentage copper tends increasingly to act as a graphitizer, breaking down the carbides. Above this percentage it exercises an indirect hardening effect. In gray iron, copper also tightens up the pearlite matrix and refines the graphite; thus in castings of varying sections it promotes uniformity of hardness.

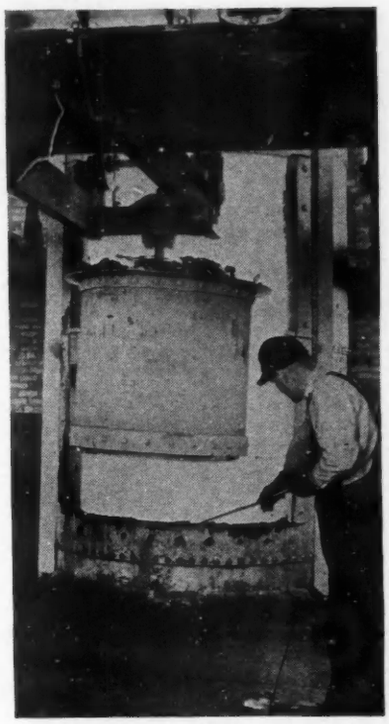
"For each 1.0 per cent of copper added, the silicon must be lowered by 0.35 per cent to maintain the same degree of chill. The improvement due to copper additions is well shown in transverse tests, and these additions are particularly effective in the presence of high manganese or of chromium or nickel. Copper accelerates the annealing of Blackheart malleable iron."

Molybdenum and vanadium are not used alone, as a rule, but in combination with nickel or both nickel and chromium. Their effect is to increase the strength and hardness of cast iron. The most pronounced effect of vanadium is that of a deoxidizer; it refines the grain and prevents a dendritic formation, which latter is undesirable on the whole. Molybdenum increases the heat-resisting qualities of the cast iron and therefore is especially valuable in castings which are exposed to high temperatures in service.

It has long been known that at high temperatures cast iron "grows" and that when parts of it are subjected to high temperatures for long periods or to a rapid succession of heating and cooling cycles, they distort in consequence. The phenomenon naturally is of most importance in the case of large units, such as large steam and Diesel engines, but there is good reason to believe that some of the troubles from distortion of automobile engine cylinders and the cracking of piston crowns and cylinder and head castings is due to this cause. The subject has received special attention in late years because of the increase in the degree of superheat used in steam plants and consequent trouble from growth of cast fittings.

By "growth" is understood the permanent increase in the linear dimensions of the parts under the influence of high temperatures. Its rate is measured in inch per inch per hour. Growth normally increases with the temperature to which the material is exposed. "Creep" is the increase in the length of a part or test specimen subjected to a stress at high temperatures, and is also measured in inch per inch per hour.

One of the chief causes of growth is the breaking up of the cementite in pearlite, whereby graphite is formed and an increase in volume produced. As



At the top of the fiery cupola this bucket load is just being pushed into position to be dumped through the bottom where it will melt and soon be poured out through the bottom for molding

the cause of the growth therefore is a change in the state of the carbon from the combined to the graphitic, it might be expected that a low percentage of combined carbon in the iron would tend to lessen growth, and this is confirmed by the results of tests. High percentages of alloying elements such as nickel-chromium are very effective in reducing growth. Tests made at the (British) National Physical Laboratory showed that under certain conditions a high-test cast iron having only 0.08 per cent combined carbon but 5.72 per cent of silicon had a rate of growth of only 5×10^{-5} in. per in. per hour, as compared with 1.2×10^{-7} in. per in. per hour in the case of ordinary cast iron containing 1.10 per cent of combined carbon and 1.27 per cent of silicon. The resistance of cast irons to both creep and growth may be greatly improved by a suitable heat treatment, which produces in advance the physical changes in the structure of the material which are the causes of these phenomena.

The usual method of testing cast iron for strength is by what is known as the transverse test. A cylindrical test bar is used, which is supported at the ends and has a gradually-increased load applied to it at the center. The test bars are 23 in. long and usually 1.2 in. in diameter, though other diameters are also being used. In fact, the technique of the transverse test is still under development. The test bars are tested in the "as cast" condition, that is, without machining. This, of course, makes it necessary that a method of pouring be developed which assures a high degree of accuracy in the diameters of the bars poured, as the strength index of the material, the "modulus of rupture", is calculated from the load required to break the test bar, the span, and the diameter of the bar. One reason for testing the bars in the "as cast" condition is that many metallurgists are of the opinion that the surface layer has greater strength than the core material, and that if the surface metal were machined off, lower test results would be obtained.

In order that the test results may be dependable, test bars for transverse tests should be free from burnt-on sand and should have a relatively smooth surface. Consequently, the method of casting these test bars is of considerable importance. Three different methods of casting have been tentatively adopted by the American Society for Testing Materials. In one method the bars are cast in a vertical position and poured from the top; in another they are cast in a horizontal position (horizontal mold), and in the third, they are cast in a position inclined about 8 deg. to the horizontal (horizontally-inclined mold), being cast from the lower end. At the National Bureau of Standards a fourth method has been developed, in which the bars are cast vertically and from the bottom (bottom-poured vertical mold).

A comparison of test bars produced by the four methods has been made at the National Bureau of Standards, and the results were communicated to the American Foundrymen's Association by A. I. Krynitsky and C. M. Saeger. Molds were made by all four methods, of a green-sand mixture consisting of eight parts of molding sand to one part of sea coal, tempered to approximately 7 per cent of moisture and faced with a non-graphitic carbonaceous refractory material.

It was found that vertically-cast test bars, especially those cast from the bottom, approached much closer to uniformity than bars cast in horizontal or horizontal-inclined molds. In general, the strength and hardness of the bars increased with the maximum heating temperature, regardless of the method of pouring.

Chilled Castings

In recent years cast iron has been put to a number of uses where great surface hardness is desirable. An ex-

ample of such applications is to camshafts for engines employing mushroom-type cam followers, as well as for the followers (or tappets) themselves. In order to minimize wear, these parts must have great surface hardness.

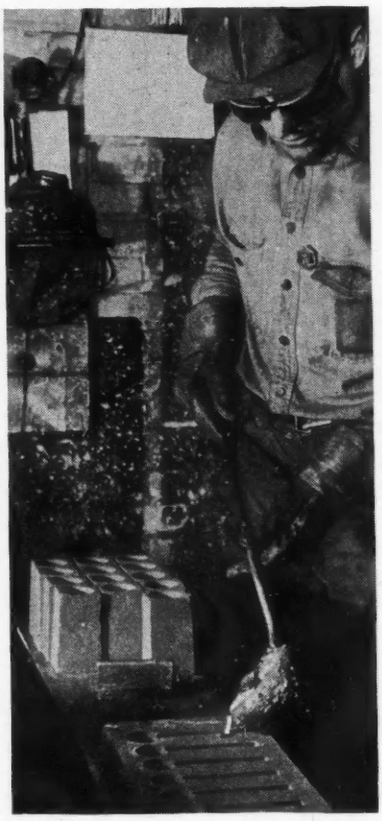
About ten years ago it was found that steels of practically the same chemical composition often exhibit entirely different characteristics when carburized and quenched, and this led to a grouping into normal and abnormal steels, the normal steels being those which acquire a good, uniform case in the case-hardening process. It was later found that the difference between the normal and abnormal grades was largely one of degree of deoxidation. If the steel is highly refined or well deoxidized, it will harden uniformly, whereas a poorly deoxidized steel will not.

Some work carried out in the Department of Engineering Research, University of Michigan, and reported in a recent A.F.A. paper, indicates that the hardening qualities of cast iron can be similarly influenced. It was found that the deoxidation practice definitely influences the hardenability, as determined by Rockwell tests on specimens that had been quenched in oil from a temperature of 1525 deg. F. Small additions of aluminum (one of the best deoxidizers known) produced a great change in the hardenability of certain base irons. These base irons, cast in standard test bars of 1.2 in. diameter, showed a uniform degree of (Rockwell) hardness throughout their section, while with an addition of 0.029 per cent of aluminum the hardness decreased rapidly from the surface, where it was substantially the same as that of the base iron, to the center, where it was some ten points lower. Materially larger additions of aluminum merely lowered the Rockwell hardness of the material by a few points as compared with the base iron, but left the hardness uniform throughout the section.

This observation led to a distinction between shallow-hardening and deep-hardening irons. There were indications that the shallow-hardening irons show greater rates of deflection than the deep-hardening. The shallow-hardening irons in the as-cast state show less tensile strength but greater impact strength.

Piston-Ring Material

Piston rings are usually cast of close-grained gray iron of substantially the same composition as that used for cylinder blocks. With increase in the specific outputs of engines, and consequent increase in the mean cycle temperature, the duty of piston rings has become more severe, and efforts have been made to improve the materials, so as to better maintain the resiliency and reduce the wear. In the case of piston rings, the wear problem is complicated by the fact that any increase in the wear resistence of the rings may be accompanied by increased wear of the cylinder bore. Similarly, a change to a more wear-resistant material for the cylinder block or cylinder liners may result in more rapid wear of the rings and call for the use of better material in these too.



Pouring the samples that are taken from each ladle of molten iron into the test or chill bar molds. The chill bars into which the hand ladle is pouring hot iron are broken after they are cold and experts can tell by the fracture of the bar whether or not the iron is of the proper hardness

For use in the engines of passenger cars, rings of a special gray iron containing a somewhat larger amount of total carbon and also somewhat more silicon than the usual cylinder block material seems to be giving good results. A representative specification for piston-ring iron is as follows:

Silicon	2.60 - 2.90
Sulfur ...less than	0.10
Phosphorus	0.45 - 0.55
Manganese	0.60 - 0.80
Total carbon	3.60 - 3.90
Combined carbon...	0.65 - 0.75

The material must not only possess the necessary springiness or resilience, but must also be sufficiently heat-resistant so that it will not lose its resilience prematurely in service. The manner of distribution of the graphite flakes or plates in the pearlike matrix seems to have quite a bearing on the wear resistance.

Piston rings operate under the most adverse conditions in aircraft engines, which have medium-carbon steel cylinders and may even be nitrided, which makes them extremely hard. In such cylinders, rings of alloy cast iron are generally used. The alloying elements employed for irons for such heavy-duty piston rings include nickel, chromium and molybdenum. All of these alloying elements increase the hardness of the material. This increase in the hardness of the ring material is said to result in an increase in the rate of bore wear in the case of a relatively soft block, but to have the contrary effect in the case of hard blocks, such as those made of molybdenum steel, high-nickel steel case-hardened, and nitrided steel. The wear on the alloy-iron rings is less than that on similar-dimensioned plain cast iron rings in every case. Rings of the usual grades of gray iron show a Brinell hardness of the order of 250, while rings of either chrome-nickel or molydenum iron may have a Brinell hardness of more than 400.

Rapid cooling of cast iron, which results in a fine distribution of the graphite is not conducive to good wear-resistance values. Slow cooling, on the other hand, also has a detrimental effect from the standpoint of wear resistance, as it results in the formation of free ferrite, which scores easily. The wear resistance of cast iron seems to be improved by coarseness of grain, and one writer has sought to explain this phenomenon by saying that where there is an abrasive action, the larger grains are not so easily torn out of the structure as small ones. It should be understood, however, that cast irons with large graphite flakes are superior from the anti-wear standpoint. A high-test alloy iron that has been used successfully in piston rings for aircraft engines contains 1.96 per cent silicon, 0.075 per cent sulfur, 0.37 per cent phosphorus, 0.47 per cent manganese, 3.54 per cent total carbon, 2.91 per cent graphitic carbon, 0.63 per cent combined carbon, 1.26 per cent nickel, 0.23 per cent chromium and 0.17 per cent molybdenum.

Centrifugal Castings

Iron castings of hollow cylindrical (or tubular) shape are sometimes poured in molds rotating at high speed, whereby the iron as it solidifies is subjected to centrifugal force instead of merely to the force of gravity. A finer, denser grain is produced, the castings are free from blow holes, and the modulus of

Girls cleaning cores preparatory to placing them in position in the molds

rigidity and the strength are claimed to be greater than in sand castings of similar material. Automotive parts sometimes made by the centrifugal casting process include piston rings and cylinder liners.

Where a hollow cylindrical casting is poured in a sand mold, solidification starts simultaneously at the outer and inner surfaces. Thus occluded gases tend to accumulate in the center, thereby producing a porous structure. The only chance for the gases to escape is upward, in the direction of cylinder length, and this makes a long path. When hollow cylinders are cast in a centrifugal metal mold, cooling and solidification start on the outer surface, as there is no inner wall to the mold. There is at the same time a steep pressure gradient in the molten metal from the surface of the mold inward. At the surface of the mold the pressure is likely to be between 10 and 15 times that due to gravity, while on the inner surface it is nil. Occluded gases and any other impurities therefore need to pass only through the wall of the casting to escape, and their escape is facilitated by the steep pressure gradient in that direction.

Piston rings cast by the centrifugal process are hardened and tempered. In order that the material may respond satisfactorily to this heat treatment, the silicon content is made low. In the "as cast" condition centrifugal rings of high-test cast iron show a hardness of about 275 Brinell, and on quenching from 1525 deg. F. this is increased to 580. On tempering, however, the Brinell is lowered again, but still remains above 500. Oil hardening also lowers the tensile strength and the modulus of rigidity, but tempering restores part of the loss. The centrifugal process has been applied to the production of automotive castings particularly in England.

Cast Iron Composite Brake Drums

Up to a few years ago brake drums were almost universally made in the form of pressings of low-carbon steel, but this soft steel does not make a good surface for brake shoes with hard linings to work against, as it scores easily. For this reason cast iron is now generally used as a lining against which the brake shoe works, the structural part of the drum still being made of pressed steel. The iron used for this purpose is a high-carbon, medium-silicon mixture which is spun into the pressed-steel frame or shell under centrifugal force. One manufacturer uses the following analysis: Total carbon, 3.10-3.25 per cent; combined carbon, 0.60-0.75 per cent; silicon, 2.00-2.20 per cent; manganese, 0.60-0.80 per cent; phosphorus, 0.25 per cent max.; sulfur, 0.12 per cent max.; nickel, 0.50-1.50 per cent; chromium, 0.30-1.00 per cent; molybdenum, 0.40-0.70 per cent.

In the production of the drums, the shell is heated by the electrical induction process to a temperature of about 1600 deg. F., clamped in the chuck of a spinning machine, and the machine started. While this is being done, a weighed amount of electric-furnace iron is poured into an attached runner basin, through which the molten iron is introduced into the hot shell. The iron becomes fused to the red-hot steel, and thus a firm bond is established between

(*Turn to page* 920, *please*)

Automotive *Materials* NEW DEVELOPMENTS

Conferences on Fatigue and Creep of Metals at M.I.T.

Creep and fatigue of metals will be discussed in a series of conferences and lectures at the Massachusetts Institute of Technology, June 21 to July 16. The program will be under direction of Professor John M. Lessells of the Institute's department of mechanical engineering.

Dr. H. J. Gough, superintendent, engineering department of the National Physical Laboratory, England, has done extensive research work investigating underlying causes of fatigue failure of metals and will present a series of lectures on the subject.

It is now established that strength of steel at high temperature is a function of time. Tensile strength of medium carbon steel at 500 deg. C. is 54,000 lb. per sq. in., provided the duration of test is six min. If time is increased to 240 min., temperature remaining the same, strength decreases to 4000 lb. per sq. in. The phenomena of decrease in strength of metals when subjected to high temperatures over a long period of time is known as creep.

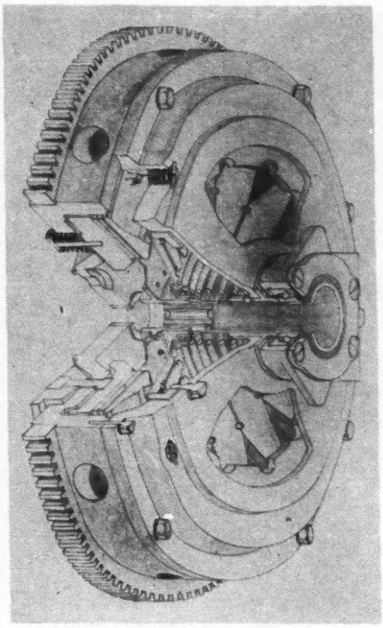
Dr. A. Nadai, associated with the research laboratories of the Westinghouse Electric and Mfg. Co., will give a series of lectures on this subject. Actual design problems will not be neglected. C. R. Soderberg, manager, steam turbine department, Westinghouse Electric and Mfg. Co., will discuss application of this knowledge to steam turbine

decade ago a California firm engaged in the production of such linings, but whatever their merits may have been, these linings did not come into use as original equipment at the time. It may be, of course, that the troubles which they were intended to remedy were not sufficiently acute to warrant the change. The demands made on clutch linings, especially, have greatly increased since that time. For some time now it has been rumored that the introduction of metallic clutch facings and brake linings was impending, and we are now in position to announce that one company is actually turning out clutch facings of this type, while another hopes to be able to enter the market in the course of a month or so. The chief requirements, of course, are a relatively high coefficient of friction, adequate resistance to the effects of high temperatures, and a low rate of wear. The facings, of course, should not be too heavy, especially in the case of the clutch, and the cost should be sufficiently low so as to make the product commercially practicable.

Metallic clutch facings have been produced for some time past by the General Metals Powder Co. of Akron Ohio, and marketed under the trade name Gempco. They have seen extended service on the clutches of motor coaches and are said to have established a service record of 300,000 miles without renewal.

These friction facings are made from powdered materials, partly metallic and partly non-metallic. The principal metallic element entering into the composition is copper, which is mixed with other metallic elements, such as tin and lead, in the powdered form. The metallic constitutents give the shoe the necessary mechanical strength to enable it to withstand the stresses due to the load carried, while the non-metallic constituents serve to control the frictional properties. These non-metallic constituents are of two kinds, one of which, consisting of graphite or powdered mica, or both, has lubricating properties and therefore tends to reduce the coefficient of friction (and the rate of wear), while the other consists of materials tending to raise the coefficient of friction. Materials included in this latter group include silica, clay, carborundum, and fused aluminium oxide.

All of the various ingredients are first prepared in the powdered state, and are then mixed in the proper proportions and introduced into metallic molds or dies. In these dies they are subjected to high pressures, varied in accordance with the composition of the particular mixtures and the use for which the product is intended. The facings so formed are later subjected to a heat treatment in a special reducing or non-oxidizing atmosphere. The temperature is carried to somewhere between 1000 deg. Fahr. and the fusing point of the more fusible metallic element of the mixture, and as a result of this high temperature and the non-oxidizing atmosphere, the metallic constituents are welded into a continuous, porous, malleable mass, the pores being filled with the non-metallic constituents. After being removed from the dies the clutch facings are drilled and countersunk, and they are then ready to be applied to the clutch disk in the usual manner.



A 13 in. Twin Coach Powerflo automatic centrifugal clutch in which Gempco No. 193 metallic lining is used

Clutch facings produced by this process have a lower coefficient of friction than the conventional type with an asbestos base, hence the pick-up is more gradual; yet, because of the lower friction coefficient, the heat generated is little if any greater, but whatever temperature the lining may reach, its frictional characteristics and rate of wear are not materially influenced, because it has been heat-treated at a temperature described as "above red heat," which is never equalled in service.

One of the important advantages claimed for Gempco friction facing is that its coefficient of static friction is considerably greater than its coefficient of sliding friction. This allows the clutch to slide freely while the load is being picked up, yet hold firmly after the car has attained a uniform speed.

Gempco friction lining is protected by U. S. Patent No. 2,072,070 issued to John S. Fisher of Akron, Ohio, on Feb. 23, 1937, and assigned by him to the General Metals Powder Co.

New Handbook on Vanadium Steels and Irons

New metallurgical handbook just published by the Vanadium Corp. of America, New York, gives complete review material and reference source data for chemical composition, physical properties, heat treatment, recommended applications and fabricating procedure of all irons and steels in which vanadium is an alloying element.

Structural steels for light and heavy sections,S.A.E. alloy and related high-test steels, spring steels, cast steels, tool steels and nitriding steels are treated comprehensively, with complete data on physical properties and heat treatment. In each case, conditions under which most favorable service results can be expected are specifically outlined, and suggestions are made for correlating choice of alloy steel and its heat treatment with the fabricating procedure to be used.

Many charts and tables are included which are based on authentic tests. Bibliographic references under each chapter head also include a great deal of new work. A special chapter of the volume is devoted to consideration of high-test alloy cast irons.

Price of the volume is $1.25, but it is available without charge to executives and engineers actually engaged in using or specifying alloy steels and irons.

Heavy Alloy Used For Counterweights in Engine Crankshafts

An alloy of great density and of comparatively low price has been developed in the research laboratories of the General Electric Co., Wembley, England, by mixing powdered tungsten with a small proportion of a metal of lower melting temperature, so as to obtain a liquid phase by heating to a moderate temperature. Either copper or nickel may be used as the alloying element. The process was described by Dr. C. J. Smithells in a recent issue of *Nature*.

To the powdered tungsten is added from 5 to 10 per cent of copper, nickel, or an alloy of these two metals, in the powdered state, the mixture being compressed in a steel mold of any desired form, and then heated to 2640 deg. Fahr. for one hour, in an atmosphere of hydrogen. A shrinkage of about 20 per cent on the linear dimensions occurs while the alloy is cooling.

These tungsten alloys were originally intended for laboratories working with radium, but they also have found several industrial applications, notably in connection with counterweights for

design. Development of satisfactory tests at high temperature will be discussed by Professor F. H. Norton of the M.I.T. staff.

Other lecturers on strength of materials will be Professors Lessells, Irving H. Cowdrey, and Charles W. MacGregor, all of whom are M.I.T. staff members. Last two days of the session will be devoted to presentation of papers by industrial authorities on the subjects of creep and fatigue.

Thickness of Nickel Coatings Measured by New Method

In general, protective value of nickel coatings on either steel or brass, including those covered with the usual thin chromium layer, depends largely upon the thickness of the nickel. This has usually been specified in terms of average thickness, but now a definite minimum thickness is often required.

A rapid, non-destructive, method for measuring the thickness of nickel coatings on metals such as brass and zinc was described briefly in the May issue of the Technical News Bulletin, issued by the National Bureau of Standards.

A small spring balance is used to measure the force of attraction between the nickel coating and a small permanent magnet. Thickness of the nickel is indicated by a dial which is standarized to a similar nickel coating of known thickness. Before testing for thickness of nickel coating with the equipment, the test piece should be annealed for a short time at 750 deg. Fahr.

Synthetic Polymers — Non-Inflammable Celluloid Substitutes Shown at Leipsig Fair

Among the most interesting exhibits at this year's Leipzig Spring Fair were a number of new synthetic resins. There were shown for the first time synthetic polymers which are essentially non-inflammable substitutes for celluloid. These new materials are not the result of a poly-condensation, like the product of the phenol-formaldehyde reaction, but are due to a synthesis of polymerization of simple, non-saturated organic compounds. The raw materials used include ethylene, acetylene, butadiene, formaldehyde, vinyl chloride, vinyl acetate, styrene, and the ester of acrylic acid.

The new synthetic products have very large molecules, somewhere between 50 and 1000 times as large as those of the raw materials. It is possible to vary at will, and gradually, the viscosity and other properties of the synthetic products obtained, by changing the temperature of operation and the catalyst employed. These new materials are said to be already in use in the production of tubes, orifice plates for pumps (which are often of quite complicated form), electric tools (to which they are specially adapted by reason of their insulating properties), acid pumps, etc.

Polymerization is effected by heating non-saturated, liquid compounds (acrylic acid, vinyl or other organic compounds), possibly in the presence of addition agents, in a chamber whose plane walls can yield while the process is going on. The walls of the chamber are of glass and are separated by compressible distance regulators.—*Chimie et Industrie* for May.

Metallic Materials for Clutch and Brake Linings

In the past, non-metallic friction materials have been used almost exclusively for automobile clutches and brakes, and on the whole they have given very satisfactory service, but in certain applications the life of these friction facings and linings has not been all that might be desired. The severity of the service conditions varies greatly, of course; conditions are generally more severe in city than in country driving, as stops and starts are much more frequent in the city, and the generation of heat and consequent wear and tear on the friction facings therefore are greater in the city. The conditions also are more severe in the case of buses than in that of private passenger cars, as the former have to make stops at nearly every street corner, and after every stop their great mass must be brought up to speed again, which necessarily involves considerable slippage of the clutch members. The ultimate demands on clutch facings, however, come in the case of automatic clutches. These must be so designed that they will be completely disengaged and cause no drag as long as the engine is idling, and yet they may be called upon to transmit the full engine torque at a few hundred revolutions per minute above idling speed. The pressure with which the clutch disks are forced together varies gradually with the speed, and a condition can easily be imagined where the holding power of the clutch is insufficient to transmit the load which the engine tries to impose upon it, and where there is, therefore, continuous slipping. This results in the generation of abnormal heat, which usually quickly destroys the ordinary friction lining with an asbestos base and a bituminous or similiar binder.

At one time multiple-disk-in-oil clutches were widely used. With these there was never any trouble from excessive wear of the friction surfaces, yet these clutches were not satisfactory, because of the great inertia of the multiple-disk driven unit, which tended to impart heavy shocks to the gear teeth when clashing, and because of the tendency of the clutch to drag in cold weather when the oil became quite viscous. As a result, there was a general change to the single-plate clutch (the twin-plate in heavy commercial applications). In general, this type of clutch gives very satisfactory service, in spite of the fact that engine powers in both private passenger cars and commercial vehicles have increased from year to year and friction surfaces naturally could not be increased in proportion; but in some of the most difficult applications in recent years the performance of clutches has not been entirely satisfactory.

The idea of metallic linings for brakes and clutches is not entirely new, and the writer remembers that about a

Close-up view of gasoline filler tank neck hose made of Thiokol, a molded synthetic rubber plastic. List of parts made of Thiokol includes: gas tank grommet, Chrysler (Royal); gasoline tank filler neck hose, Plymouth, Dodge, and DeSoto; gasoline feed line, Reo and Hudson; gasoline tank grommets, G.M. trucks; gage gaskets, Greyhound buses. Thiokol is an oil-proof rubber said to have most of the physical properties of natural rubber

crankshafts of internal combustion engines and for gyroscopes. The most important application probably is to interruptors for electric circuits carrying heavy currents. The tensile strength of the fritted alloy is 49,000 lb. per sq. in. and its density is 50 per cent greater than that of lead.

Simplified Practice Recommendation on Coated Abrasive Products Is Revised

The Division of Simplified Practice, National Bureau of Standards, has announced that printed copies of recommendation number R89-36 on coated abrasive products are now available.

The recommendation, originally effective September 1928, and revised in 1932, established simplified lists of flint, emery-coated, and other kinds of coated abrasives. These lists include type of backing, size of sheet, type of coating, and grade number for each class of goods. Various products are indicated as being regularly made by some or all manufacturers and carried in stock by them, or as non-standard items which may be discontinued when no longer in demand for special purposes.

The present edition covers certain additions, eliminations, and changes in classification to meet current needs. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for five cents each.

Produce Substitute for Celluloid and Glass from Potato Starch

It is reported that a Dutch engineer, van Linge, with the assistance of a number of chemists, has succeeded in producing a thermoplastic mass from the starch of potatoes, which in the form of plates may be used as a substitute for celluloid and glass.

The material is quite transparent and not very inflammable, and its cost of production is said to be very low. From the fact that its specific gravity is only 1.3, it has been concluded that it is an ester or an ether of starch.

It can be readily drilled, sawed, turned and laminated. It is said to be transparent also to ultra-violet rays.

Synthetic Insulating Compound Similar to Rubber and Non-Combustible

A new synthetic insulating compound has been recently introduced commercially by the General Electric Co. under the trade name Flamenol. While similar to rubber in its characteristics, it contains no rubber and will not support combustion. In addition to being non-combustible, Flamenol, is highly resistant to moisture, acids, alkalies, and oils. It has excellent aging characteristics and is strong mechanically. Its properties are such that it can be made a very soft and flexible compound, or one with celluloid-like rigidity. It can be put into solution for coating or impregnating, and can be compounded, filled, calendered, and extruded in much the same fashion as rubber.

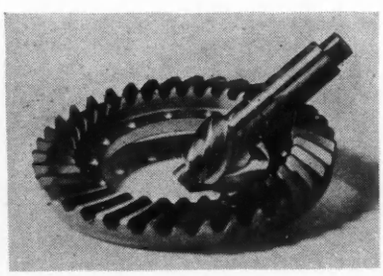
Among other applications, Flamenol-insulated cable is recommended for machine-tool wiring and for battery and coil leads.

Flamenol has a permanently smooth finish and foreign materials do not readily adhere to its surface. It is available in a variety of colors for circuit tracing. For most applications Flamenol is used without any protective finish, such as braid, lead, or armor. It is only where the cable will be subjected to extreme mechanical abuses that such a finish is necessary.

Chrome - Molybdenum Carburizing Steel Developed to Cut Costs

A chrome-molybdenum carburizing steel, unofficially designated as SAE 4120, has been developed by the Climax Molybdenum Co., New York, to reduce cost of carburized parts for applications where the core properties of very expensive carburized steels are not essential.

Characteristics of the new steel when made to controlled grain size are listed by the manufacturer as: low cost; can be quenched from box with minimum, uniform distortion; takes hard, wear resistant case; develops good core properties; and has excellent machinability.



Ring gear and pinion made from "4120," the new chrome-molybdenum carburizing steel developed by the Climax Molybdenum Co.

A partial list of parts already made of "4120" includes medium and heavy duty gears and pinions, automotive hypoid gears and pinions, wrist pins, worms, sucker rod couplings, shafts and anti-friction bearings.

Safety Glass Tested for Resistance to Heat, Cold, Sun Rays

Safety glass for windshields and windows of automotive vehicles must resist destructive effects of weather and actinic rays of sunlight and must be suitably strong; it is also essential that outer surfaces be parallel. Some interesting tests for safety glass are conducted at the Ford Rouge plant, Dearborn, Mich.

One test consists of submerging a sample of safety glass in boiling water for eight hours. This is intended to insure that no low-boiling point solvents are present in the material cementing the two glass plates to the middle sheet of transparent plastic. If bubbles should appear they would indicate presence of unwanted solvents.

The test for resistivity of safety glass to discoloration caused by actinic sun rays comprises exposure of a safety glass sample for 1000 hrs. to rays of a quartz mercury vapor tube. This is known as the uniarc test. Emanations from the tube are rich in ultra violet rays.

Parallelism of glass surface is checked by a laboratory instrument resembling a surveyor's transit. The laboratory technician sights through the device to a glass sample against a target of hair-fine lines and slightest divergence from parallelism is revealed.

In the "steel-ball drop" test, a half pound steel ball is dropped on a specimen from various heights. Safety glass usually resists breaking until the ball is dropped from 16 ft. The steel ball strikes at a speed of 21.8 mi. per hr. with a blow of eight lb.-ft.

Specimens also are placed in a humidity cabinet, with temperature of 140 deg. Fahr. and humidity of 95 to 97 per cent, to determine whether the seal will resist these conditions.

Another test calls for exposing specimens in a refrigerated cabinet where they are subjected to temperatures of 10 deg. above zero, zero, and 10 deg. below zero to check reaction to cold climates.

A final test is to expose specimens to sunlight on the roof of the glass plant, tilted at an angle of 45 deg., for two years.

Still other specimens are sent to Ford branches in Florida and California for testing in service cars.

Just Among Ourselves

Automobile Prices Will Go Up—How Much?

WHEN the National Automobile Show opens in New York in October, the paramount issue facing the motor-vehicle industry will be how to price the product for 1938. One official, very high in the sales councils of the industry has gone off-the-record with two aphorisms. To wit:

1. Prices won't go as high as they should.

2. This is the first year since 1932 that I have been unable to predict an increase in business for the coming year, and the reason is higher prices.

Background for the first statement is found in the jittery labor situation and unfavorable Government attitude toward increasing the price of consumer goods. Several executives in the industry believe the public will stand for reasonable price increases; others believe the public will react unfavorably to them, no matter how much necessity there may be behind them.

We are far from ready to predict the size of the inevitable increases, but we are willing to bet that public reaction to particular cars on the first few days of the automobile shows, will have a large part in determining the pricing of the cars in question. The economic price level will be determined in advance of the shows, of course, but the problem will be to determine how much of the indicated increase can be safely added to the 1937 price without jeopardizing volume of sales.

The problem is acute enough to have started rumors that one or two makes of respectable volume will enter the 1938 season with the fewest possible engineering changes, so that present prices can be maintained, or that increases can be held down.

Vacuum Cleaning Financed Deals

The delivered-in-Detroit price scheme of the automobile manufacturers has pretty well cleaned up misunderstandings of what they were getting on the part of automobile purchasers, when the purchase was an unfinanced deal. But a great deal of the good inherent in the plan has been cancelled, in the case of financed deals, in which many dealers have included "packing charges" which were not designed for public notice. Such charges, disguised under various euphemisms, were intended to compensate the dealer for going overboard in his trading allowance on used cars and for other failures to be a good business man.

For several years GMAC has refused to buy "packed" deals. Other finance companies, while opposing the "pack" in principle and doing what they could to eliminate it, have not been in a position to refuse business which it stigmatized.

Now, according to the National Association of Sales Finance Companies, there is a determined effort on the part of both "national" and "local" finance companies to end the practice of "packing." Conferences are being held in various localities and agreements are being made by finance companies in those localities not to accept packed deals after a certain date. Only moral force backs the agreements, but it seems to have rolled up considerable inertia, and is reported to be effective. —H. H.

Financial Analysis of

Net Income‡ (Thousands of Dollars) and Dividends

	Net Income‡ 1929	1932	1933	1934	1935	1936	Dividends 1929	1932	1933	1934	1935	1936
American Chain	$3,279	d$2,986	d$432	$492	$1,646	$2,968	$935	.....	.....	.....	$463	$2,631
Armstrong Cork	4,891	d2,259	3,204	1,973	3,435	5,278	1,853	.....	.....	$302	1,058	3,023
Bendix Aviation	7,417	d1,601	1,243	1,903	3,164	3,025	3,126	$315	.....	.....	524	3,146
Bohn Aluminum & Brass	2,620	d721	1,495	1,518	1,589	1,580	1,580	.....	$352	1,057	793	1,322
Borg Warner	6,685	d598	1,196	3,751	6,983	8,327	4,365	530	518	1,663	2,215	4,724
Briggs Manufacturing	2,427	d1,896	1,591	5,122	9,266	10,411	.....	490	.....	3,391	5,836	7,770
Campbell, Wyant & Cannon	1,279	d313	40	d17	654	1,045	663	.....	.....	.....	223	774
Clark Equipment	1,324	d802	d108	d74	6	513	602	80	138	266	266	459
Detroit Steel Products	1,024	d788	d199	153	311	875	130	.....	.....	.....	.....	291
Eaton Manufacturing	1,502	d674	360	978	1,838	2,391	894	82	131	835	1,124	1,740
Electric Auto-Lite	14,514	1,364	684	1,212	2,909	4,510	5,694	1,987	293	298	1,021	3,049
Electric Storage Battery	7,911	1,260	2,022	2,004	2,248	2,595	4,542	2,198	1,815	2,042	3,177	2,496
Fedders Mfg. Co	231	d103	d215	89	234	302	75	.....	.....	.....	62	250
Federal-Mogul	306	d150	62	102	209	398	171	.....	.....	.....	15	150
Gabriel Co	d339	d108	d131	d141	d113	d77	.....	.....	.....	.....	.....	.....
Hayes Body (1)	d245	d294	d288	d122	d59	d22	.....	.....	.....	.....	.....	.....
Houdaille-Hershey	1,519	d590	d112	d931	2,456	2,202	1,080	108	.....	435	1,687	2,397
Marlin-Rockwell	2,707	d123	111	538	1,112	1,634	2,182	308	236	753	1,103	1,357
McCord Radiator	618	d649	25	d28	251	132	332	.....	.....	.....	.....	.....
Midland Steel Products	2,555	d221	673	681	1,634	2,160	1,637	759	664	664	1,037	1,873
Motor Products	2,141	d518	d217	135	1,080	1,372	2,079	286	.....	.....	783	880
Motor Wheel	3,480	d1,187	122	410	1,088	1,801	1,985	.....	.....	.....	361	935
Mullins Mfg. Co	477	d696	d268	187	424	525	210	.....	.....	.....	.....	283
Murray Corporation	1,308	d1,881	d777	d796	1,430	907	827	16	16	16	8	465
Raybestos Manhattan	3,206	d1,457	685	751	1,374	1,691	1,538	453	386	642	638	1,112
Spicer Manufacturing	2,120	d1,414	d131	670	629	1,489	300	264	216	257	210	1,110
Stewart-Warner	6,839	d2,445	d1,791	572	1,724	2,113	4,178	.....	.....	.....	621	1,242
Thompson Products	1,231	d162	174	381	709	785	606	85	.....	51	45	477
Timken Detroit Axle	1,513	d1,194	d1,257	426	1,173	2,160	1,017	194	194	193	175	2,268
Timken Roller Bearing	14,155	d483	2,173	3,486	7,483	9,257	7,223	3,316	1,688	2,773	7,234	9,043
Trico Products	2,250	965	1,418	1,772	3,567	.....	834	937	937	937	919	.....
L. A. Young Spring & Wire	2,213	d196	418	811	1,816	1,899	1,102	388	.....	486	876	1,328
Total	$103,158	d$22,940	$11,770	$28,006	$62,270	$74,246	$51,760	$12,796	$7,584	$17,061	$32,474	$56,595

‡ After taxes, interest, etc.
(1) 1935 data are for 9 months period ending Sept. 30th.
d Deficit.

All figures are in thousands of dollars

Plant and Property† and Good Will, Patents, etc.

	Plant and Property† 1929	1932	1933	1934	1935	1936	Good Will, Patents, etc. 1929	1932	1933	1934	1935	1936
American Chain	$13,136	$11,758	$10,871	$10,104	$9,256	$8,515	$2,649	$832	$635	$585	$530	$409
Armstrong Cork	25,402	24,636	18,104	17,561	17,097	17,436	966	830	185	122	108	94
Bendix Aviation	7,985	10,196	9,634	9,066	9,141	9,227	33,281	.....	.....	.....	.....	.....
Bohn Aluminum & Brass	5,115	2,693	2,564	2,459	2,589	2,700	181	124	104	87	70	54
Borg Warner	17,545	15,750	14,248	13,290	13,919	14,766	679	421	405	380	144	124
Briggs Manufacturing	20,446	11,039	9,840	10,170	9,585	11,800	.....	.....	.....	.....	.....	.....
Campbell, Wyant & Cannon	3,875	3,363	3,190	3,210	3,189	3,483	.....	.....	.....	.....	.....	.....
Clark Equipment	6,083	4,424	4,011	3,888	4,034	4,609	.....	.....	.....	.....	.....	.....
Detroit Steel Products	3,104	2,818	2,660	2,677	2,686	2,718	.....	.....	.....	.....	.....	.....
Eaton Manufacturing	10,908	7,476	6,832	7,201	7,355	7,465	337	271	223	216	300	.....
Electric Auto-Lite	11,280	8,238	7,625	8,991	11,553	12,218	.....	.....	.....	.....	.....	.....
Electric Storage Battery	13,018	10,715	9,965	9,513	8,994	9,131	.....	.....	.....	.....	.....	.....
Fedders Mfg. Co	1,450	1,120	1,007	910	886	928	.....	.....	.....	.....	.....	.....
Federal-Mogul	1,078	990	909	872	868	924	.....	.....	.....	.....	.....	.....
Gabriel Co	743	682	659	524	519	465	.....	.....	.....	.....	.....	.....
Hayes Body (1)	3,661	2,263	2,060	1,609	1,542	1,393	.....	.....	.....	.....	.....	.....
Houdaille-Hershey	4,635	7,104	6,404	6,040	5,758	6,303	.....	.....	.....	.....	.....	.....
Marlin-Rockwell	2,599	1,856	1,627	1,469	1,351	1,442	.....	.....	.....	.....	.....	.....
McCord Radiator	4,140	2,732	2,339	2,363	2,219	2,241	.....	.....	595	595	595	83
Midland Steel Products	6,014	4,933	4,729	4,804	4,679	4,540	6,014	4,933	4,729	4,804	1,874	1,847
Motor Products	4,364	3,647	3,584	3,626	2,411	2,478	.....	.....	.....	.....	.....	.....
Motor Wheel	7,230	6,273	5,588	5,631	5,712	5,614	.....	.....	.....	.....	.....	.....
Mullins Mfg. Co	4,434	3,235	1,745	1,717	1,747	1,999	86	14	22	27	34	37
Murray Corporation	20,790	10,099	9,640	9,423	8,904	9,708	301	.....	.....	.....	.....	.....
Raybestos Manhattan	7,543	6,769	6,453	6,406	6,786	7,113	595	595	595	595	595	595
Spicer Manufacturing	8,807	4,652	4,061	3,953	4,176	4,337	209	.....	.....	.....	.....	.....
Stewart-Warner	17,211	11,794	8,992	7,530	7,217	7,447	.....	.....	.....	.....	.....	.....
Thompson Products	3,298	3,459	1,958	1,980	2,256	2,515	834	827	824	831	835	831
Timken Detroit Axle	7,730	6,819	6,078	5,517	5,051	4,829	.....	1,684	1,624	1,564	1,505	1,437
Timken Roller Bearing	23,207	18,769	17,288	15,928	15,371	15,169	.....	.....	.....	.....	.....	.....
Trico Products	1,601	1,606	1,497	1,445	1,501	.....	351	336	330	309	285	.....
L. A. Young Spring & Wire	4,028	3,355	3,517	3,866	4,184	4,606	479	275	1,110	900	.....	.....
Total	$.72,460	$215,263	$189,679	$183,743	$182,536	$188,119	$46,962	$11,142	$11,381	$11,015	$6,875	$5,516

† After depreciation.

f Parts Makers, 1929-1936

Cash and Securities

	1929	1932	1933	1934	1935	1936
American Chain	$969	$1,403	$1,248	$2,003	$1,425	$992
Armstrong Cork	2,776	8,142	5,994	8,552	8,613	8,009
Bendix Aviation	8,132	3,537	4,996	7,233	8,452	5,415
Bohn Aluminum & Brass	2,948	483	134	162	194	201
Borg Warner	8,401	7,493	7,637	7,842	9,070	6,706
Briggs Manufacturing	2,324	6,691	6,913	8,642	7,856	7,667
Campbell, Wyant & Cannon	569	770	618	590	778	475
Clark Equipment	1,798	2,227	2,052	1,973	1,422	1,212
Detroit Steel Products	1,345	380	145	163	212	764
Eaton Manufacturing	1,212	2,030	2,375	2,462	1,914	1,340
Electric Auto-Lite	10,527	918	1,269	2,394	1,830	1,536
Electric Storage Battery	9,734	16,190	16,362	16,377	16,781	16,877
Fedders Mfg. Co.	220	236	118	85	261	276
Federal-Mogul	113	83	52	50	111	68
Gabriel Co.	167	99	113	84	47	111
Hayes Body (1)	223	11	12	46	47	95
Houdaille-Hershey	1,997	2,038	1,793	2,293	2,871	1,856
Marlin-Rockwell	5,832	3,521	3,100	2,682	3,846	3,539
McCord Radiator	316	104	116	156	171	146
Midland Steel Products	7,363	4,907	4,600	4,199	4,351	4,798
Motor Products	3,048	2,060	1,399	2,054	2,808	3,356
Motor Wheel	3,960	1,537	298	645	959	999
Mullins Mfg. Co.	441	84	149	64	409	257
Murray Corporation	1,617	2,965	706	319	1,545	613
Raybestos Manhattan	3,472	3,325	2,641	2,666	2,235	2,351
Spicer Manufacturing	704	1,122	731	866	601	751
Stewart-Warner	3,039	2,851	1,274	1,043	2,427	1,334
Thompson Products	740	162	212	174	335	248
Timken Detroit Axle	3,680	3,050	2,700	2,065	2,029	1,552
Timken Roller Bearing	13,615	13,556	14,210	16,455	16,616	15,797
Trico Products	1,620	3,700	4,421	5,314	7,717	.....
L. A. Young Spring & Wire	2,182	939	394	1,130	794	583
Total	$105,084	$96,614	$88,782	$100,783	$108,727	$89,924

Receivables

	1929	1932	1933	1934	1935	1936
American Chain	$5,862	$1,902	$2,472	$2,373	$3,025	$4,459
Armstrong Cork	4,695	1,688	2,116	1,938	3,479	5,602
Bendix Aviation	2,331	1,344	1,525	2,254	3,109	4,198
Bohn Aluminum & Brass	1,242	475	909	1,043	1,410	1,972
Borg Warner	3,188	1,269	1,729	4,042	5,493	10,158
Briggs Manufacturing	5,893	1,294	3,741	5,244	6,319	8,282
Campbell, Wyant & Cannon	484	143	278	378	905	963
Clark Equipment	631	118	160	237	394	592
Detroit Steel Products	1,649	558	506	858	914	1,457
Eaton Manufacturing	1,034	689	626	1,561	2,036	2,671
Electric Auto-Lite	3,983	1,742	1,915	3,057	5,382	6,783
Electric Storage Battery	7,217	3,297	3,158	3,319	3,451	4,194
Fedders Mfg. Co.	423	178	132	224	286	338
Federal-Mogul	312	163	219	275	439	507
Gabriel Co.	79	39	51	67	40	69
Hayes Body (1)	605	142	84	116	68	149
Houdaille-Hershey	687	237	645	1,161	1,455	1,928
Marlin-Rockwell	432	140	212	703	456	495
McCord Radiator	1,067	341	451	474	641	838
Midland Steel Products	1,010	770	863	1,419	1,874	2,416
Motor Products	517	329	440	759	1,201	1,606
Motor Wheel	994	586	663	848	1,292	2,254
Mullins Mfg. Co.	470	214	223	401	527	579
Murray Corporation	2,828	731	1,941	1,480	1,503	2,071
Raybestos Manhattan	1,732	1,019	1,434	1,580	2,013	2,557
Spicer Manufacturing	1,217	293	613	695	1,129	1,111
Stewart-Warner	4,082	1,168	1,298	1,824	2,090	3,481
Thompson Products	698	356	425	621	1,084	1,513
Timken Detroit Axle	1,763	1,255	1,083	1,785	3,148	3,912
Timken Roller Bearing	1,963	551	1,545	2,047	2,294	3,276
Trico Products	691	389	414	594	1,305	.....
L. A. Young Spring & Wire	1,074	472	700	1,019	1,828	2,149
Total	$60,853	$23,892	$32,571	$44,396	$60,590	$82,580

All figures are in thousands of dollars

Inventories

	1929	1932	1933	1934	1935	1936
American Chain	$7,596	$4,646	$4,401	$4,669	$5,007	$6,130
Armstrong Cork	18,544	5,227	8,773	7,868	9,287	10,521
Bendix Aviation	5,239	3,066	4,020	4,110	5,498	7,239
Bohn Aluminum & Brass	2,212	2,977	4,592	4,304	4,952	4,701
Borg Warner	7,632	3,877	5,625	8,283	9,158	13,032
Briggs Manufacturing	(a) 9,867	(a) 5,539	(a) 6,352	(a) 8,891	(a) 12,739	(a) 13,688
Campbell, Wyant & Cannon	817	209	454	538	689	1,179
Clark Equipment	2,436	1,117	1,106	1,227	1,376	2,041
Detroit Steel Products	1,425	563	625	618	810	1,011
Eaton Manufacturing	2,298	1,797	1,961	2,306	2,494	3,114
Electric Auto-Lite	4,336	1,954	2,223	3,480	6,328	7,974
Electric Storage Battery	7,576	3,492	4,031	4,220	5,248	6,207
Fedders Mfg. Co.	588	198	335	486	546	917
Federal-Mogul	497	410	486	558	709	848
Gabriel Co.	162	132	99	63	61	54
Hayes Body (1)	1,951	179	113	179	213	141
Houdaille-Hershey	1,756	723	913	1,380	2,193	2,491
Marlin-Rockwell	1,646	602	896	1,053	986	1,161
McCord Radiator	1,208	414	626	687	889	1,002
Midland Steel Products	1,132	643	1,357	1,072	1,695	1,791
Motor Products	1,210	524	1,202	881	1,180	1,444
Motor Wheel	2,821	1,144	2,214	1,695	2,263	3,068
Mullins Mfg. Co.	1,750	861	460	504	343	660
Murray Corporation	4,630	2,186	2,653	2,862	3,225	4,658
Raybestos Manhattan	4,759	1,933	3,309	3,477	4,138	4,618
Spicer Manufacturing	4,328	610	1,089	1,456	1,920	2,638
Stewart-Warner	7,771	2,194	2,581	3,176	3,540	5,237
Thompson Products	1,995	809	876	1,034	1,812	2,482
Timken Detroit Axle	4,788	2,634	2,413	3,019	3,161	3,955
Timken Roller Bearing	10,676	4,927	7,074	7,629	9,872	10,840
Trico Products	668	451	435	489	710	.....
L. A. Young Spring & Wire	1,204	771	1,552	1,042	1,301	1,875
Total	$125,518	$56,809	$74,846	$83,256	$104,343	$126,717

Current Assets

	1929	1932	1933	1934	1935	1936
American Chain	$14,427	$7,950	$8,121	$9,045	$9,457	$11,580
Armstrong Cork	27,337	15,538	17,884	20,047	21,638	25,248
Bendix Aviation	25,573	7,947	10,541	13,597	17,059	16,852
Bohn Aluminum & Brass	6,450	4,298	5,648	5,537	6,634	6,874
Borg Warner	19,222	12,674	14,992	20,168	23,720	29,897
Briggs Manufacturing	18,084	13,525	17,007	22,778	26,914	29,636
Campbell, Wyant & Cannon	1,870	1,122	1,351	1,506	2,372	2,617
Clark Equipment	5,304	3,501	3,358	3,463	3,222	3,880
Detroit Steel Products	4,419	1,501	1,276	1,639	1,936	3,232
Eaton Manufacturing	4,544	4,516	4,962	6,330	6,444	7,125
Electric Auto-Lite	18,876	4,614	5,407	8,931	13,544	16,294
Electric Storage Battery	24,567	23,111	23,691	24,044	25,604	27,418
Fedders Mfg. Co.	1,270	612	544	795	1,093	1,532
Federal-Mogul	922	657	755	882	1,259	1,423
Gabriel Co.	1,238	271	366	313	273	234
Hayes Body (1)	2,818	341	210	342	328	384
Houdaille-Hershey	4,441	3,033	3,351	4,834	6,419	6,276
Marlin-Rockwell	7,910	4,263	4,208	4,438	5,288	5,195
McCord Radiator	2,592	860	1,194	1,318	1,701	1,986
Midland Steel Products	9,505	6,321	6,820	6,690	7,860	9,004
Motor Products	4,775	2,913	3,041	3,695	5,226	6,431
Motor Wheel	7,775	3,266	3,175	3,188	4,514	6,321
Mullins Mfg. Co.	2,661	1,159	831	969	1,179	1,496
Murray Corporation	9,074	5,883	5,301	4,661	6,272	7,342
Raybestos Manhattan	9,963	6,278	7,385	7,723	8,403	9,548
Spicer Manufacturing	6,249	2,025	2,433	3,018	3,651	4,500
Stewart-Warner	14,892	6,213	5,155	6,043	8,057	10,053
Thompson Products	3,433	1,327	1,513	1,829	3,231	4,243
Timken Detroit Axle	10,231	6,940	6,195	6,869	8,374	9,419
Timken Roller Bearing	26,254	19,056	22,829	26,131	28,783	29,912
Trico Products	3,054	4,896	5,649	6,998	10,415	.....
L. A. Young Spring & Wire	4,550	2,196	2,650	3,193	3,923	4,607
Total	$304,280	$178,807	$197,843	$231,014	$274,793	$300,559

(a) Includes dies, jigs, etc., billed.

Financial Analysis of Parts Makers—1929-1936

(Continued from preceding page)

Current Liabilities

	1929	1932	1933	1934	1935	1936
American Chain	$1,826	$610	$648	$697	$1,293	$2,665
Armstrong Cork	8,524	578	1,465	1,154	2,459	4,238
Bendix Aviation	3,542	1,340	1,501	1,859	2,868	3,609
Bohn Aluminum & Brass	1,375	223	702	798	1,976	1,827
Borg Warner	4,392	1,118	1,816	4,688	6,341	11,319
Briggs Manufacturing	5,454	1,909	2,683	7,234	9,048	11,193
Campbell, Wyant & Cannon	502	136	167	247	621	861
Clark Equipment	569	102	140	210	342	714
Detroit Steel Products	1,539	851	693	534	584	1,462
Eaton Manufacturing	1,304	605	680	1,490	1,958	2,105
Electric Auto-Lite	4,784	1,018	843	2,410	4,926	7,606
Electric Storage Battery	2,633	822	972	1,362	1,677	1,807
Fedders Mfg. Co.	320	70	93	158	251	210
Federal-Mogul	355	253	241	261	436	422
Gabriel Co.	64	38	43	46	75	69
Hayes Body (1)	1,072	277	198	275	229	170
Houdaille-Hershey	1,001	388	569	959	1,451	1,839
Marlin-Rockwell	1,800	118	111	173	896	493
McCord Radiator	560	258	384	655	841	1,080
Midland Steel Products	1,431	239	845	826	1,263	1,925
Motor Products	1,043	285	980	679	1,552	2,109
Motor Wheel	1,091	1,438	1,366	758	1,184	1,957
Mullins Mfg. Co.	225	581	466	363	233	445
Murray Corporation	2,271	581	1,225	1,680	1,356	2,755
Raybestos Manhattan	1,143	313	609	771	1,237	1,888
Spicer Manufacturing	2,504	418	626	778	1,264	1,806
Stewart-Warner	2,773	783	1,404	1,155	1,741	2,948
Thompson Products	1,483	522	541	542	1,394	1,542
Timken Detroit Axle	1,538	279	501	860	919	1,680
Timken Roller Bearing	3,694	512	1,572	1,674	3,101	3,776
Trico Products	846	615	779	1,079	2,368	.....
L. A. Young Spring & Wire	679	292	456	775	1,019	1,676
Total	$62,337	$17,572	$25,319	$37,150	$56,903	$78,196

Working Capital

	1929	1932	1933	1934	1935	1936
American Chain	$12,601	$7,340	$7,472	$8,348	$8,164	$8,915
Armstrong Cork	16,813	14,960	16,369	18,892	19,179	21,011
Bendix Aviation	22,031	6,607	9,040	11,738	14,191	13,243
Bohn Aluminum & Brass	5,076	4,076	4,946	4,739	4,658	5,047
Borg Warner	14,830	11,556	13,176	15,480	17,379	18,578
Briggs Manufacturing	12,630	11,615	14,324	15,545	17,865	18,443
Campbell, Wyant & Cannon	1,369	986	1,184	1,259	1,751	1,757
Clark Equipment	4,735	3,399	3,218	3,253	2,881	3,166
Detroit Steel Products	2,880	649	583	1,105	1,351	1,771
Eaton Manufacturing	3,240	3,911	4,283	4,841	4,486	5,020
Electric Auto-Lite	14,092	3,596	4,564	6,521	8,619	8,688
Electric Storage Battery	21,933	22,289	22,718	22,683	23,927	25,611
Fedders Mfg. Co.	950	542	451	637	842	1,322
Federal-Mogul	567	404	514	621	823	1,001
Gabriel Co.	1,174	233	323	267	198	165
Hayes Body (1)	1,746	64	12	67	99	215
Houdaille-Hershey	3,439	2,610	2,781	3,875	4,967	4,437
Marlin-Rockwell	6,109	4,145	4,098	4,265	4,392	4,703
McCord Radiator	2,032	602	810	663	861	905
Midland Steel Products	8,074	6,082	5,975	5,864	6,597	7,079
Motor Products	3,733	2,628	2,061	3,016	3,674	4,322
Motor Wheel	6,684	1,828	1,810	2,431	3,325	4,364
Mullins Mfg. Co.	2,436	577	365	606	946	1,051
Murray Corporation	6,803	5,301	4,075	2,982	4,916	4,587
Raybestos Manhattan	8,819	5,965	6,776	6,951	7,166	7,660
Spicer Manufacturing	3,746	1,608	1,807	2,240	2,387	2,694
Stewart-Warner	12,119	5,430	3,751	4,888	6,316	7,105
Thompson Products	1,951	805	972	1,286	1,837	2,701
Timken Detroit Axle	8,693	6,661	5,695	6,009	7,455	7,739
Timken Roller Bearing	22,560	18,544	21,257	24,457	25,682	26,136
Trico Products	2,209	4,281	5,006	5,919	8,047	.....
L. A. Young Spring & Wire	3,871	1,904	2,194	2,417	2,904	2,931
Total	$239,945	$161,198	$172,610	$193,865	$217,885	$222,367

All figures are in thousands of dollars

Funded Debt

	1929	1932	1933	1934	1935	1936
American Chain	$5,200	$3,844	$4,352	$3,458	$1,568	$1,150
Armstrong Cork	.....	13,481	12,878	12,752	9,000	8,700
Bendix Aviation	101	432	302	239	142	97
Bohn Aluminum & Brass	1,902	1,767	1,411	499	.....	.....
Borg Warner	1,909	1,586	1,075	1,075	.....	.....
Briggs Manufacturing	.....	.....	.....	.....	.....	.....
Campbell, Wyant & Cannon	.....	.....	.....	.....	.....	.....
Clark Equipment	.....	.....	.....	.....	.....	.....
Detroit Steel Products	.....	.....	.....	450	350	250
Eaton Manufacturing	750	.....	.....	.....	.....	.....
Electric Auto-Lite	.....	.....	.....	40	236	150
Electric Storage Battery	.....	.....	.....	.....	.....	.....
Fedders Mfg. Co.	300	.....	.....	.....	.....	500
Federal-Mogul	.....	65	30	8	.....	.....
Gabriel Co.	.....	.....	.....	.....	.....	.....
Hayes Body (1)	.....	.....	.....	.....	.....	.....
Houdaille-Hershey	.....	.....	.....	.....	.....	.....
Marlin-Rockwell	.....	.....	.....	.....	.....	.....
McCord Radiator	2,395	2,005	1,971	1,877	1,766	1,631
Midland Steel Products	.....	.....	.....	.....	.....	.....
Motor Products	.....	.....	.....	.....	.....	.....
Motor Wheel	.....	.....	.....	.....	.....	.....
Mullins Mfg. Co.	.....	.....	.....	.....	.....	.....
Murray Corporation	3,185	2,250	2,000	1,750	.....	.....
Raybestos Manhattan	.....	.....	.....	.....	.....	.....
Spicer Manufacturing	.....	.....	.....	.....	.....	.....
Stewart-Warner	.....	.....	.....	.....	.....	.....
Thompson Products	.....	.....	.....	.....	300	200
Timken Detroit Axle	.....	940	628	.....	.....	.....
Timken Roller Bearing	.....	.....	.....	.....	.....	.....
Trico Products	35	.....	.....	.....	.....	.....
L. A. Young Spring & Wire	642	223	175	111	.....	.....
Total	$16,419	$26,593	$24,822	$22,259	$13,362	$12,678

Capital and Surplus (Includes Capital Surplus Where Given)

	1929	1932	1933	1934	1935	1936
American Chain	$22,468	$16,336	$15,763	$16,296	$16,551	$16,696
Armstrong Cork	48,724	35,200	30,843	33,157	34,747	35,596
Bendix Aviation	63,513	21,666	22,965	24,867	27,369	27,390
Bohn Aluminum & Brass	8,637	5,434	6,576	7,038	7,644	8,167
Borg Warner	32,278	28,256	28,964	30,782	34,297	35,799
Briggs Manufacturing	32,530	22,895	24,486	26,237	30,155	32,797
Campbell, Wyant & Cannon	5,556	5,085	5,126	5,089	5,521	5,799
Clark Equipment	10,955	7,851	7,424	7,349	7,095	7,243
Detroit Steel Products	5,790	3,547	3,345	3,498	3,713	4,297
Eaton Manufacturing	11,085	11,169	11,422	11,192	12,204	12,556
Electric Auto-Lite	26,021	14,708	14,660	17,969	20,428	21,431
Electric Storage Battery	37,013	35,355	35,400	35,212	35,370	36,146
Fedders Mfg. Co.	2,134	1,731	1,513	1,600	1,757	1,811
Federal-Mogul	1,605	1,363	1,425	1,527	1,721	1,968
Gabriel Co.	1,825	1,161	1,021	880	767	1,329
Hayes Body (1)	5,532	2,734	2,185	1,771	1,716	1,711
Houdaille-Hershey	8,974	9,381	9,272	9,894	10,448	10,595
Marlin-Rockwell	8,943	6,735	6,609	6,394	6,409	6,814
McCord Radiator	4,317	2,182	2,120	1,994	2,178	1,810
Midland Steel Products	15,238	13,494	13,502	13,519	14,116	14,402
Motor Products	7,996	6,343	5,754	6,734	4,128	6,593
Motor Wheel	14,932	9,036	8,557	8,970	9,488	10,354
Mullins Mfg. Co.	7,353	4,004	2,258	2,445	2,798	3,105
Murray Corporation	24,864	12,674	11,954	11,252	14,120	14,569
Raybestos Manhattan	17,879	14,966	15,294	15,433	16,169	16,751
Spicer Manufacturing	13,369	8,211	7,864	7,230	7,649	8,028
Stewart-Warner	30,667	17,183	13,129	11,528	13,137	14,008
Thompson Products	6,552	5,245	3,905	4,239	4,904	5,762
Timken Detroit Axle	17,851	15,299	13,699	13,912	14,666	14,294
Timken Roller Bearing	46,458	39,506	40,080	40,793	41,042	41,256
Trico Products	4,703	6,522	7,003	7,837	10,036	.....
L. A. Young Spring & Wire	8,684	7,102	6,989	7,112	7,145	7,716
Total	$554,416	$392,374	$381,107	$393,730	$419,488	$426,793

Parts Business Larger in 1936

(Continued from page 892)

Net working capital was increased by 26 companies.

The buoyant market of 1936, during which year costs were not so high as at present, resulted in a fairly general increase in earnings. Only five companies failed to increase net incomes available for dividends. Those which did so improve their positions included two companies which reported smaller deficits. Only two of the companies which reported smaller net incomes showed severe contractions from the dollar viewpoint, although one of the companies with small dollar income suffered the loss of almost half of it.

Dividend payments, as was to be expected after the passage of the law that imposed surtaxes on undistributed net incomes, showed large increases. Only one company paid less than in the preceding year, although it earned more.

Combined capital and surplus, including capital surplus where given, was increased by all but three of the reporting companies.

Production Lines

From left to right are shown above the Lincoln and Lincoln-Zephyr final inspection lines

Apprentice Training

Shortage of skilled workers is a major problem in all manufacturing industries and has brought new problems and embarrassing delays. Apprentice training seems to be of immediate importance and it has been met in various ways. At the recent meeting of the AFA, Macon P. Miller, personnel director, Lynchburg Foundry, described the apprentice training plan of his company. While the program is not an elaborate one, they have a set-up in which an attempt is made to give each boy some experience in the work of every department of the foundry. This is supplemented with classroom instruction six hours each week. Apprentices start at common labor rate which is increased three cents per hour every six months. At present no compensation is given for time spent at school but there are compensating rewards, as for example a week's vacation with pay the first year, if the school record is good, and two weeks' vacation with pay after the second year of apprenticeship.

Saves 24 Hours

If someone told you how to save 24 hours in machining time, you would certainly look into the matter quite thoroughly. This is exactly what has been accomplished on a single routine operation. The operation is one step in the fabrication of landing gear strut terminals of S.A.E. 4130 steel for a 30,000 lb. airplane. The saving is accomplished by flame cutting the metal so nearly to the required shape that machining operations were only a small fraction of what would otherwise be required. By means of the oxy-acetylene process the parts are cut from 9¼ x 12-in. billets to within ¼ in. of finished dimensions. Each flame shaped part weighs approximately 180 lb. If flame cutting were not available and the work had to be cut out by other methods, the parts in the rough would weigh about 314 lb. each.

A little more than 2 hr. work with the flame shaping machine saves at least 24 hr. of machining time, to say nothing of the material saving.

Endless Variety

Speaking of specialists, we chanced to visit the plant of M. D. Hubbard at Pontiac. This company goes 'way back in the production of the useful welch plug which today has assumed the status of a precision product. Not everybody knows that these people are called upon to produce literally hundreds of special springs and intricately formed stampings for every conceivable use. Apart from the ingenious spring winding machines and presses, Hubbard operates a large department devoted exlusively to four-slide forming machines whose product seemingly is limited only by the mechanical ingenuity of skilled tool designers. Because these people devote their energies to specialized work of this character, they seem to be in the happy position of being able to make any kind of intricate stamping in strip or wire by bending the four-slide machine to their will.

Foundry Show

Among the educational exhibits at the recent foundry convention at Milwaukee were some demonstrations by Electro Metallurgical Corp. and Linde Air Products. The latter featured actual work of machine cutting and hand cutting by the oxy-acetylene torch. Electro-Met had a display of silicon, manganese, and chromium briquets with a decorative background developing the fact that E.M. briquets remain unaffected until they reach the melting zone.

An Asset

Depreciation as a sales asset was the burden of a valuable paper presented before the recent convention of the National Machine Tool Builders' Association. The idea is that the best way to sell modern equipment is to show the plant management how it may avail itself of the most favorable depreciation rates from the Bureau of Internal Revenue. A fair depreciation rate should permit any factory management to build up a suitable reserve for further modernization without making inroads on the capital structure. R. E. W. Harrison, the author of the study, certainly knows whereof he speaks and can prove it.

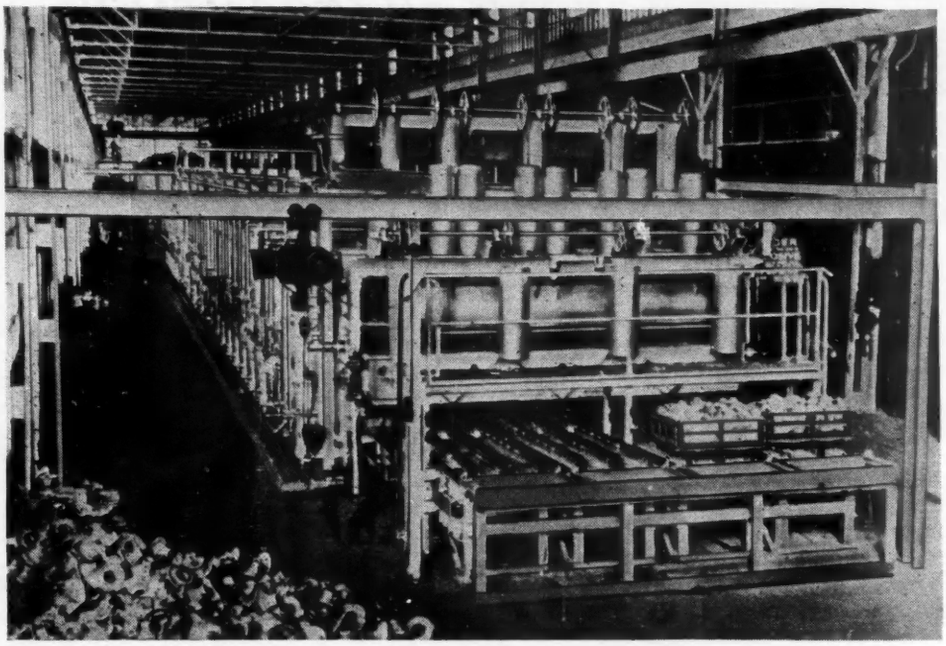
Olds Automatic

Perhaps one of the most dramatic announcements in recent years was the news of the introduction of the Olds automatic transmission which was described in AUTOMOTIVE INDUSTRIES recently. We were naturally quite interested in learning what kind of materials are used in its construction since that is an important element in any new device. We understand that all of the gears and other major parts are fabricated from a nickel-molybdenum alloy steel which follows the practice of some years' standing in building Olds transmissions.

Body Styles

As many readers of this page know, we have discussed for several years the desirability of using concealed hinges, flush-type door handles, and the other devices that aid in cleaning up body exteriors. Such details have assumed increasing importance in the past few years with the changing trend in body styling. While we know little concerning the design of bodies for the '38 season, we should not be surprised if at least one or more of the finer details are adopted for the coming year.—J. G.

Malleableizing Cycle Cut in Half



The new, four-lane 115 ft. continuous gas radiant tube, short cycle, malleableizing furnace. Surrounded by a specially prepared gas atmosphere, the work passes through on trays without the need of heavy pots or other slow heating protections. The long sought short cycle of 30 hours is being successfully achieved.

A REVOLUTIONARY development in the cast iron industry has just been accomplished with the use of gas fuel. The time required in malleableizing iron has been cut in half and the use of annealing boxes eliminated by a continuous furnace equipped with radiant gas hot tubes. For a long time metallurgists and engineers of the Saginaw Malleable Iron division of General Motors Corp. have been working on methods and processes to reduce the length of time required to graphitize white cast iron in the production of malleable iron. These were finally developed and the exacting heat requirements were found to be best interpreted by the radiant gas hot tube type of furnace.

Formerly the time cycle of 7 to 9 days, was subsequently reduced to 59 hours, and now, with this new gas furnace, they have cut it to 30 hours, a reduction of 49 per cent. This reduction in time is due, in part, to the fact that the huge mass of metal constituting the annealing pots, is no longer present to absorb the tremendous amount of heat necessary to heat them through in order to raise the temperature of the work inside.

By J. B. Nealey*

The new malleableizing furnace is continuous in operation, the hearth being provided with roller rails, the work being pushed through with mechanical pushers. As the pots are eliminated the work rides through on trays for it requires no protection whatever in the furnace.

Prevention of scaling is accomplished by surrounding the work with a prepared gas generated in a separate unit which transforms city gas into a predetermined protective atmosphere. Inasmuch as it is necessary to open the doors when the pushers operate, air tight vestibules are provided at either end of the furnace and these are purged every time the outer doors are opened and closed. This furnace is 115 ft. long and 20 ft. wide and has a daily capacity of 55 tons. There are four hydraulic pushers and four rows of work pass through at the same time. The furnace will hold 184 trays and each tray carries about 750 lbs. of castings piled to a height of 18 ins. Each tray with liners weighs 325 lbs.

The time and temperature cycle is as follows—8½ hours are required to bring the work up to a peak temperature of 1750 degrees Fahr., it is held at this temperature for 10 hours when a quick cool is given to it which drops the heat to 1400 degrees Fahr. in 1½ hours, and this is followed by 10½ hours of slow cooling when the work is ready to be discharged. The radiant gas tubes are simple alloy tubes lying within the furnace but with both ends protruding to the outside. A gas burner fires into one end of the tube and the hot products of combustion emerge at the other. The tubes thus become hot and the heat is transferred to the furnace interior without altering the atmosphere. This removes the necessity for either boxes or muffles.

Made automatic in operation by means of relays, limit switches, time clocks, etc., the operation cycle starts with all doors closed and the two outer doors locked gas tight by air cylinders. Manual operation, however, is possible and starts with an operator pressing a push button. This unlocks the outer door at the charging end. The operator then raises the door, pushes the trays of work into the vestibule and closes the door, which locks itself and opens the valve of the purge line to the vestibule.

* American Gas Association, New York, N. Y.

Wolseley "Supersix" 25 Hp. Engine

This six-cylinder passenger car engine, manufactured by Wolseley Motors, Ltd., Birmingham, England, has a bore and stroke of 82 by 110 mm. (3.23 by 4.33 in.), making its piston displacement 212.6 cu. in. The compression ratio is 6.1 and the engine develops 100 hp. at 3800 r.p.m. The valves are located in a side pocket in the head and are operated by side rods. They have dual concentric

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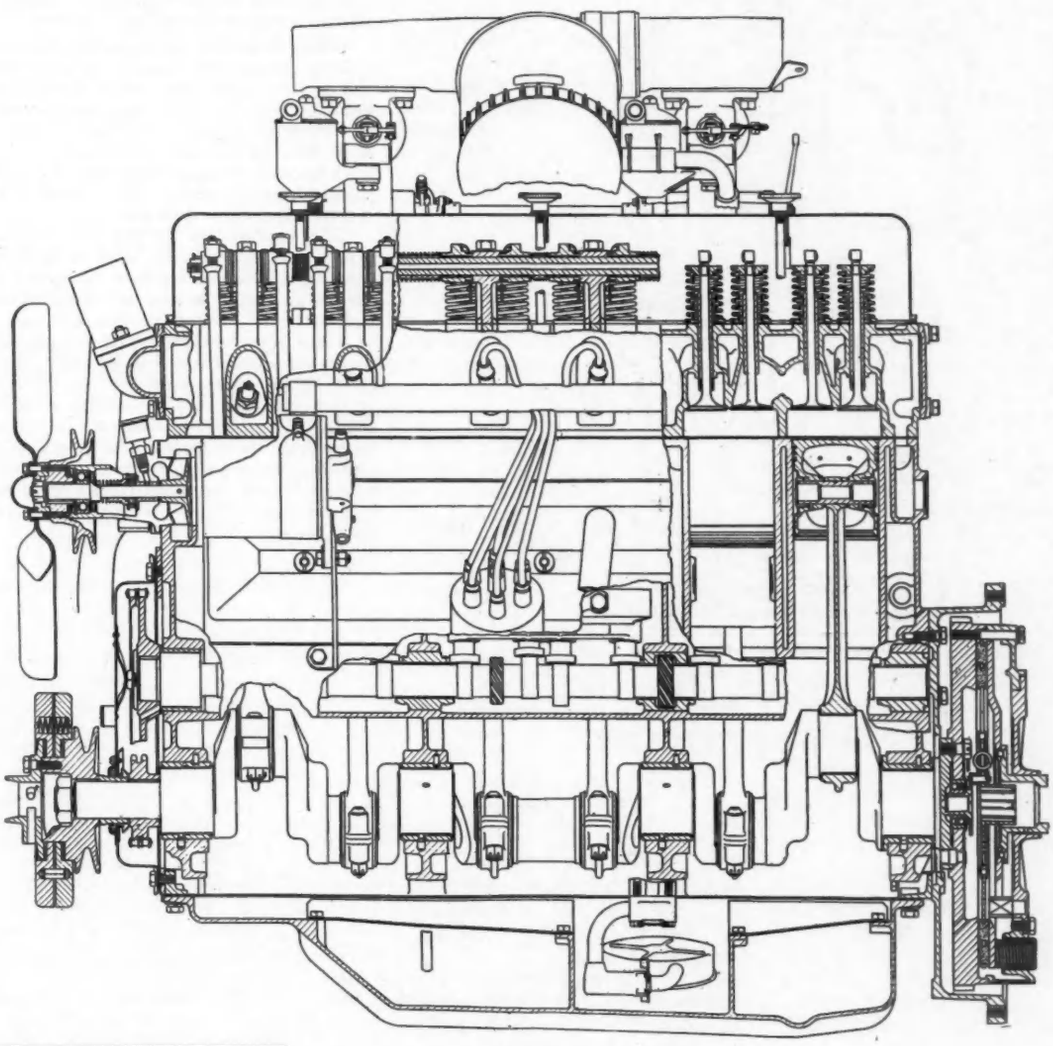
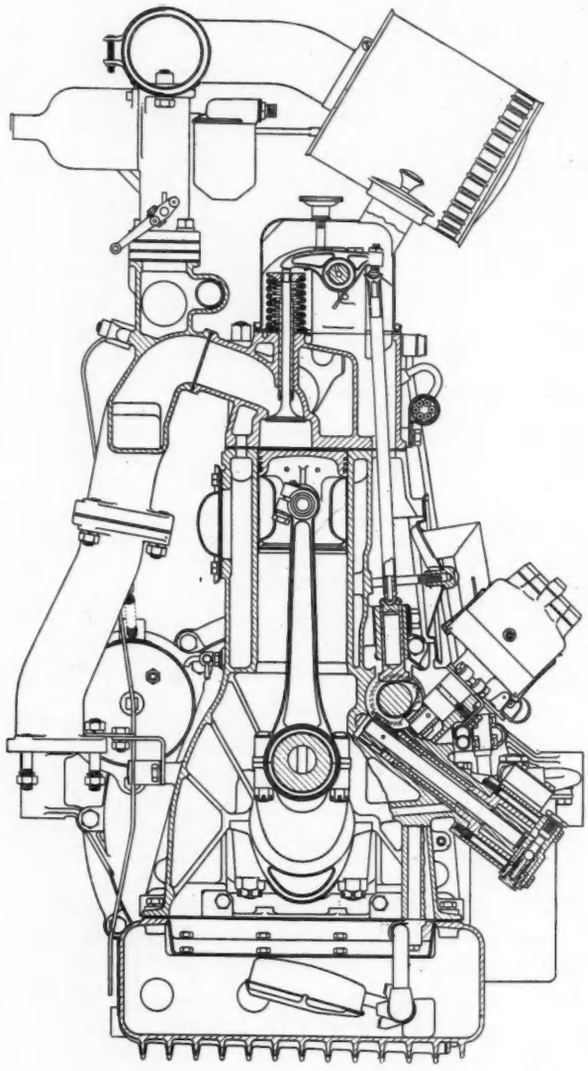


No. 30 in the AUTOMOTIVE INDUSTRIES Series of Engineering Drawings

Wolseley "Supersix" 25 Hp. Engine



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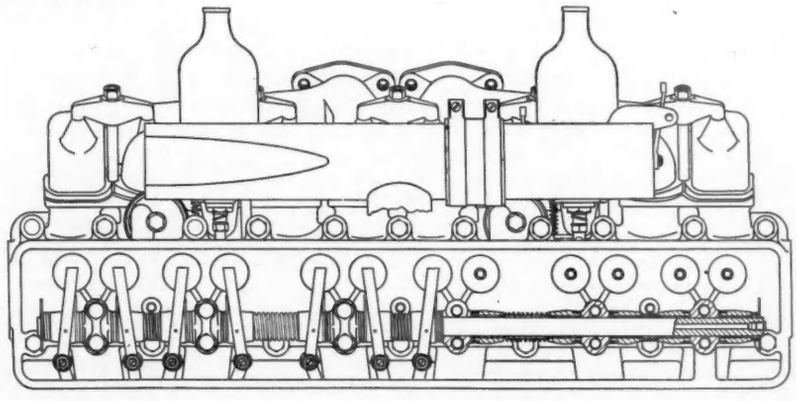
springs and are actuated by means of high-clearance 'harmonic" cams.

Other features of the engine include Flower bimetallic pistons (aluminum crown cast with steel skirt), steel connecting rods of 9½ in. center-to-center length, a four-bearing crankshaft with 2-7/16 by 2-in. main and 2-3/16 by 1⅜-in. crankpin bearings, a duplex roller-chain front-end drive, and a torsional vibration damper.

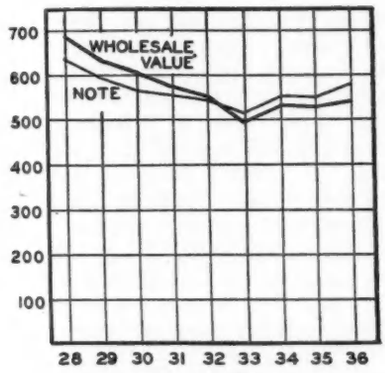
The carburetor is an S.U. piston-type dual downdraft, and is supplied with fuel by dual electric pumps. The cast aluminum sump is ribbed longitudinally to maintain the oil supply at a low temperature. The oil pump is provided with a floating intake. Water circulation is assisted by an impeller at the rear end of the ball-bearing fan shaft. The engine has a four-point mounting on rubber. The single-plate clutch, also shown in the longitudinal section, is of the cork-insert type and is supplied with oil from the engine rear bearing.



"Danger" in Financing Scouted

(*Continued from page 893*)

the ratio of instalment sales to total sales of new motor vehicles as derived from the annual survey which we make in conjunction with the National Automobile Dealers Association. If the financing ratio truly reflected the changes in the instalment selling ratio these two curves ought to be nearly parallel, whereas, it is evident that they are not. Just one-half of the year to year changes in these ratios are in the same direction, while the other half are in opposite directions. Thus the



Average installment versus average wholesale value

drop in the financing ratio in the last quarter of 1936, followed by the still greater drop in the first quarter of 1937, may mean that the public has suddenly begun to pay cash for a greater proportion of its car purchases, or it may not mean that. There is, however, nothing to suggest that the percentage of instalment sales of new motor vehicles has yet reached as great a height as it did in the year 1929, 1930 and 1931.

That the average instalment note in percentage of the price of the car has been increasing almost continuously during the period of which we have statistics is indicated by the two curves in the diagram entitled "Average Instalment Note Versus Wholesale Price." From 1928 to 1932, inclusive, the average wholesale price of all vehicles sold in this country was greater than the average retail instalment note, whereas from 1933 to 1936, inclusive, the reverse has been true. In 1928 the average instalment note was 92.4 per cent of the average wholesale value, whereas in 1936 the note was 107.2 of the wholesale value. Of course, it would be more satisfactory if we could make this comparison with the average retail selling price, but the latter is unavailable. This trend could be caused by a gradual decrease in the average down payment, or a gradual increase in the "finance charge," including the insurance premium. We have no direct figures reflecting either of these factors. In the past few years it has become customary to place insurance covering collision in addition to the fire and theft insurance formerly placed. This tends to increase the finance charge. Also there has been an increase in the length of time to pay out instalment contracts. This has a tendency to increase the finance charge. On the contrary, the finance charge considered as a per cent per month on the original unpaid balance, including the insurance, is decidedly lower now than it was at the beginning of the period under consideration. Another factor which might increase this ratio of average note to wholesale price would be an increase in the ratio of retail selling price to wholesale price, but we have no means of determining whether this has taken place.

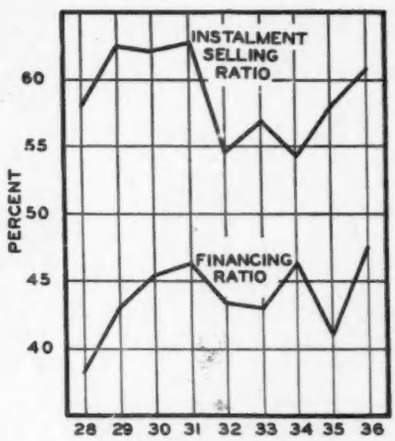
SUMMARY. From 1932 to 1936 retail automobile financing more than tripled, the ratio being 3.2. This was due, principally, to the fact that the number of new cars registered increased in the ratio of 3.15 to one. The corresponding ratio for new cars financed was 3.44, and for used cars financed 2.44. The smaller increase in used car financing results from the fact that the sale of used cars during the depression did not drop off nearly so much as the sale of new cars.

The volume of retail financing in 1936 was helped by a higher ratio of financing to registrations for new cars than in the preceding years, but the dominant factor was the increase in production and sales.

The only startling factor in the available statistics is the drop in the ratio of new car financing to registration, to 40.0 per cent in the first quarter of 1937 from 45.3 per cent in the first quarter of 1936 and 47.5 per cent for the year 1936.

Credit Conditions Better

Customers of automobile dealers made a slightly larger proportion of their purchases on a credit basis but paid for them more promptly during 1936 than during 1935, according to the Bureau of Foreign and Domestic Commerce.



Comparison of two ratios

The ratio of bad-debt losses to installment credit sales was found to be lower in 1936 than in 1935, in this survey of credit conditions which covered 14 kinds of trade located in 88 cities throughout the country.

The rate of payments on regular charge accounts of reporting automobile dealers was the highest among the 14 trades covered in the study and was also higher in 1936 than in 1935. The percentages averaged 88 for each month of 1936 and 83 in 1935, indicating that accounts receivable were outstanding 34 days and 36 days, respectively.

Average Instalment Note Versus Wholesale Value

Year	Wholesale Value	Instalment Note	Note % of Wholesale Value
1928	$687	$635	92.4%
1929	636	595	93.6
1930	606	564	93.1
1931	577	554	96.0
1932	554	546	98.6
1933	497	519	104.4
1934	536	551	102.8
1935	531	550	103.6
1936	541	580	107.2
1937	...	580*	.....

* 1st quarter

New Cars Financed In Per Cent of Registered

Year	QUARTERS 1st	2nd	3rd	4th	All Year
1928	38.0	39.2	38.0	37.7	38.3
1929	38.3	43.7	45.1	43.6	42.9
1930	41.0	47.2	46.2	48.5	45.5
1931	43.3	47.0	46.1	49.8	46.3
1932	42.4	43.9	42.1	47.4	43.5
1933	39.4	43.3	43.4	45.3	43.2
1934	43.9	47.6	46.6	46.3	46.4
1935	40.8	38.7	41.2	43.9	41.0
1936	45.3	47.9	49.4	46.8	47.5
1937	40.0	....	....	....	....

Motor Vehicle Financing Millions of Dollars

Year	RETAIL New	Used	All	Wholesale
1928	848	348	1,196	....
1929	1,126	491	1,617	678
1930	778	450	1,226	661
1931	570	380	950	554
1932	303	233	536	330
1933	392	235	627	500
1934	587	307	894	907
1935	734	424	1,158	1,403
1936	1,106	610	1,716	1,704

Cast Iron for Automobiles

(Continued from page 907)

the cast-iron lining and the steel support. This method of manufacture gives a thicker and therefore more rigid rim than could possibly be produced by stamping alone, so that distortion under the pressure of the brake shoes is reduced, and the cast iron lining gives a frictional surface which in service takes on a glaze that assures uniform wear. The "centrifuging" effect on the molten iron is so great that a dross is formed on the inside of the casting which analysis has shown to contain a considerable proportion of sulfur and manganese (the manganese evidently in the form of a chemical compound of lower density than the iron).

Cast Iron Camshafts

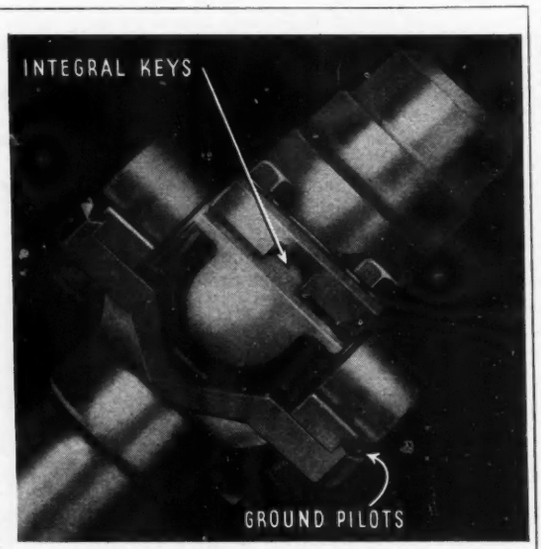
Camshafts do not call for a material of great torsional or tensile strength, but a rather high degree of hardness is required on the cam surfaces, and rather high rigidity is also desirable, as this decreases the deflection under the impact of valve lift and thus tends to make valve operation more nearly silent. A low silicon, low-manganese iron is employed, and hardness on the cam surfaces is obtained by chilling or heat treatment. In the production of some of these camshafts no artificial chills are used; the shafts are cast in green sand molds, and the cam surfaces are chilled more than other parts on account of their lighter sections. The degree of chill can be controlled by both the silicon and the copper contents.

One iron used for cast camshafts contains 3.30-3.65 per cent total carbon, 0.45-0.55 silicon, 0.15-0.35 per cent manganese, 2.5-3.0 per cent copper, a maximum of 0.25 per cent chromium, a maximum of 0.05 per cent phosphorus and a maximum of 0.06 per cent sulfur. The castings are not subjected to any heat treatment and in the "as-cast" condition show about 300 Brinell hardness on the bearings and 450 on the cam surfaces.

Where chills are used in the mold it is of the utmost importance that they be accurately located, as the chilling effect does not penetrate to any great depth and if the cam lobes are not accurately located and more material has to be ground away on one side of the cam than on the other, there is a possibility that all of the chilled material will be removed and the cam surface will be relatively soft. With a molding method that assures accurate location of the cam, the amount of material allowed for finishing can be made quite small and a uniform degree of hardness over the entire cam surface assured. A depth of chill of 1/16 in. is sufficient. Of course, only the lobe or nose of the cam is hardened, the heel remaining unhardened, the same as the bearing surfaces and the distributor drive gear, if one is cast integral with the camshaft, while the fuel pump eccentric is hardened all around. As regards stock allowance for machining, 1/32 to 3/64 in. is all that is required on the chilled cam surfaces, while 1/16 in. can be allowed on the bearing surfaces.

High-Alloy Cast Irons

A number of high-alloy cast irons have been developed for uses where exceptional resistance to corrosion, freedom from growth, and special heat-expansion characteristics are called for. One of these, known as Ni-resist, contains, in addition to the usual elements, from 12 to 15 per cent nickel, 5 to 7 per cent copper, and 1.50 to 4 per cent chromium. By varying the carbon and silicon contents the material can be made to show tensile strengths of from 20,000 to 35,000 lb. per sq. in. and Brinell hardness of



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from 120 to 170. If the iron is chilled it will show from 350 to 400 Brinell.

One of the most interesting properties of the material is its high rate of heat expansion, which is of value where it is to be used in combination with light metal parts, as in cylinder liners of engines with aluminum-alloy pistons. For temperatures up to 1100 deg. F. the coefficient of heat expansion is approximately 50 per cent greater than that of ordinary cast iron. This is almost the same as the coefficient of heat expansion of high-silicon aluminum alloy. Up to 1500 deg. F. the material shows very much higher resistance to oxidation than ordinary cast iron, and the growth resulting from alternate heating and cooling is insignificant as compared with the growth of ordinary iron under the same conditions.

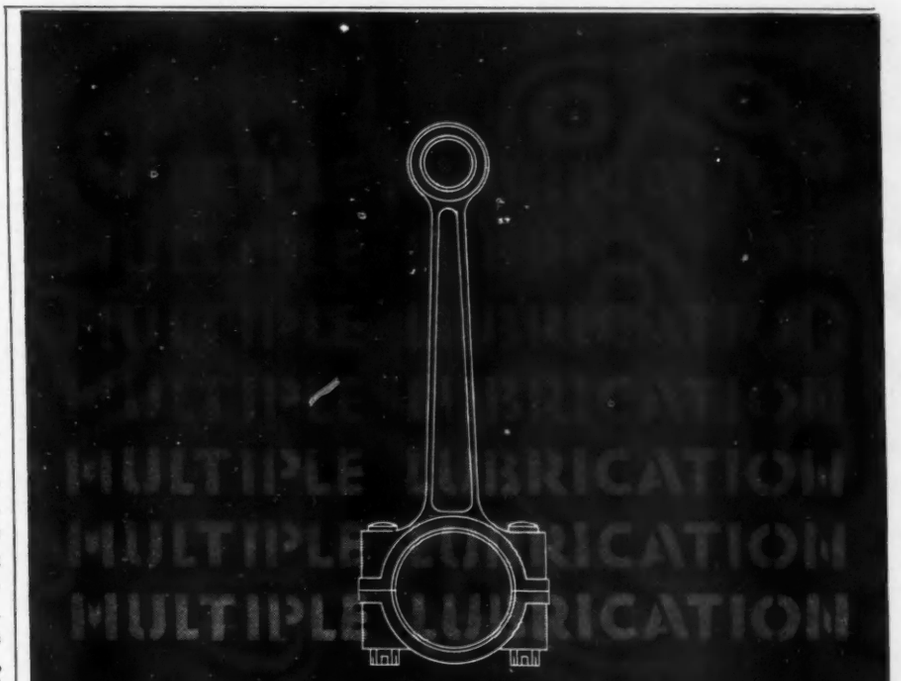
Nitricastiron

Cast iron that can be surface-hardened by the nitriding process has been developed recently and is at present used mainly for cylinder liners of Diesel and heavy-duty gasoline engines. Like the nitralloy steels, to which a similar hardening process is applied, these cast irons contain aluminum, chromium and sometimes also molybdenum and vanadium. There seem to be considerable differences in the irons developed for this purpose in this country and abroad. Thompson Products, which controls the process in this country, specifies an iron having 0.62 per cent combined carbon and 2.31 per cent graphitic carbon. The iron also contains all four of the alloying elements mentioned above, whereas an iron developed in England for the same purpose, by the Sheepbridge-Stokes Centrifugal Castings Co., Ltd., contains 1.55 per cent combined carbon, 1.10 per cent graphitic carbon and only aluminum and chromium as alloying elements. Cylinder liners made from nitricastiron by Thompson Products are nitrided for 65 hours at 950 deg. F. and then have a hardened case of 0.015 in. depth, the hardness tapering off from the outside, where it is equal to over 900 Firth diamond hardness.

A slight "nitride fuzz" produced on the surface of the liners in the nitriding furnace is removed before the liners are shipped. Some distortion is also caused, and the effects of this are eliminated by honing after the liner is inserted into the block, for which purpose an allowance of 0.002 in. on the diameter is made. Nitriding also produces a slight "growth," of the order of 0.001 in., and this is allowed for in the bore. The liners are installed in the blocks with a press fit, an interference of 0.0015 to 0.0025 in. being allowed, depending on the bore. The life of nitrided cast iron liners in commercial-vehicle engines is claimed to exceed 300,000 miles.

A relatively new field for cast material is in the production of engine crankshafts. Cast material evidently has a great appeal where only a small number of shafts are required and where the outlay for forging dies therefore would not be warranted. It is, however, also being used in the case of one large-production engine, a particular advantage in this case being that the crankshaft can be cast much closer to actual size than it could be forged, and that the amount of machining required therefore is greatly reduced, which incidentally also reduces the amount of material that must be paid for.

The material used for cast crankshafts is not cast iron but cast alloy steel, containing, in one instance, 1.35-1.60 per cent carbon, 0.85-1.10 per cent silicon, 1.50-2.00 per cent copper, 0.40-0.50 per cent chromium, 0.60-0.80 per cent managanese, a maximum of 0.10 per cent phosphorus and a maximum of 0.06 per cent sulfur. In casting these crankshafts, the furnace is cold-charged and pouring begins 3½ hours later. The tapping temperature is 2800 deg. F. and the pouring temperature, 2700-2670 deg. F. Four four-throw crankshafts



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with counterweights are poured in a single mold, in the vertical position, the mold consisting of sixteen horizontal sections made of dry sand and baked (like foundry cores). There is a large central basin into which any loose sand, dross etc., is carried, as it is in communication with the crankshaft molds. To remove shrinkage strains, the castings are first normalized, and they are subjected to a heat treatment to improve their grain structure and their physical qualities. This heat treatment consists in raising the shafts in a double-deck furnace to 1650 deg. F. in one hour, holding them at that temperature for 20 minutes, allowing them to cool to 1000 deg. in air, raising them to 1400 deg. in one hour, holding them there for one hour, and allowing them to cool to 1000 deg. before they are discharged from the furnace.

As the principal stresses on the crankshaft are torsional, torsional check tests are made on suitable specimens and these must show the following properties: Elastic limit in torsion, 88,200-96,-500 lb. per sq. in.; ultimate strength in torsion, 128,000-130,000 lb. per sq. in.; twist at elastic limit, 9-6 deg.; twist at ultimate, 16-25 deg.; Brinell hardness, 255-321.

Malleable Cast Iron

Malleable iron castings are used to a considerable extent in the automotive industry, statistics showing that more than half the total production of such castings in this country goes into automotive products. Malleable cast iron is essentially a low-silicon cast iron in which the combined carbon has been converted into graphitic carbon by an annealing process. The iron is poured into the molds for the castings differs somewhat in composition from ordinary gray iron; its carbon content is rather lower (about 2.50 per cent), and all or nearly all of the carbon is in the combined state, but the main difference is that the silicon content is much lower. After the castings have been poured they are subjected to an annealing process whereby practically all of the carbon is converted from the combined to the graphitic state. In the malleable iron the graphite is in the form of nodules embedded in a matrix of ferrite or pure iron, in contrast to cast iron, in which it appears in the form of flakes or plates interspersed between crystals of pearlite.

In the past the annealing of malleable castings has been a long and, therefore, a rather expensive process, and development work in recent years has been aimed at shortening the process and cutting the costs. The annealing process, which originally extended over a period of about a week, consists of either three or four periods. In the four-stage process the castings are (1) brought up to the annealing temperature, (2) held at the annealing temperature, (3) cooled rapidly through a certain range, and (4) cooled slowly through the remaining range. Where there are only three periods, the rapid cooling is omitted.

In modern malleable foundries the annealing is accomplished in hermetically closed kilns with a controlled atmosphere containing definite proportions of CO and CO_2, so that there is neither a carburizing nor a decarburizing action. The annealing time has been cut to a little over 30 hours. This has been made possible by the use of special gas heaters which heat the furnace charge uniformly at a rapid rate, and by the accurate control of the atmospheres. Charging and discharging are effected through vestibules at opposite ends, with double doors. Whenever the outer door is opened, air enters the vestibule, and before the inner door is opened the atmosphere in the vestibule is equalized with that in the furnace by means of a "purging valve" which is automatically controlled by the outer door of the vestibule and discharges a mixture of CO and CO_2 gas.

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